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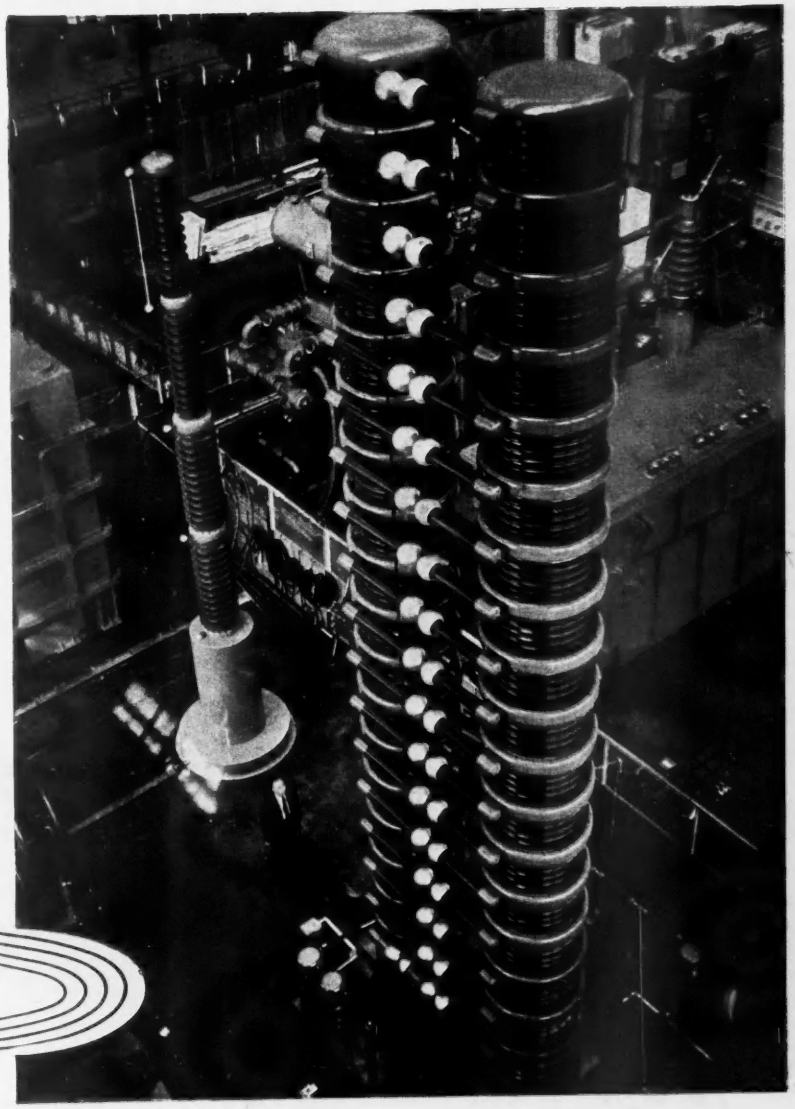

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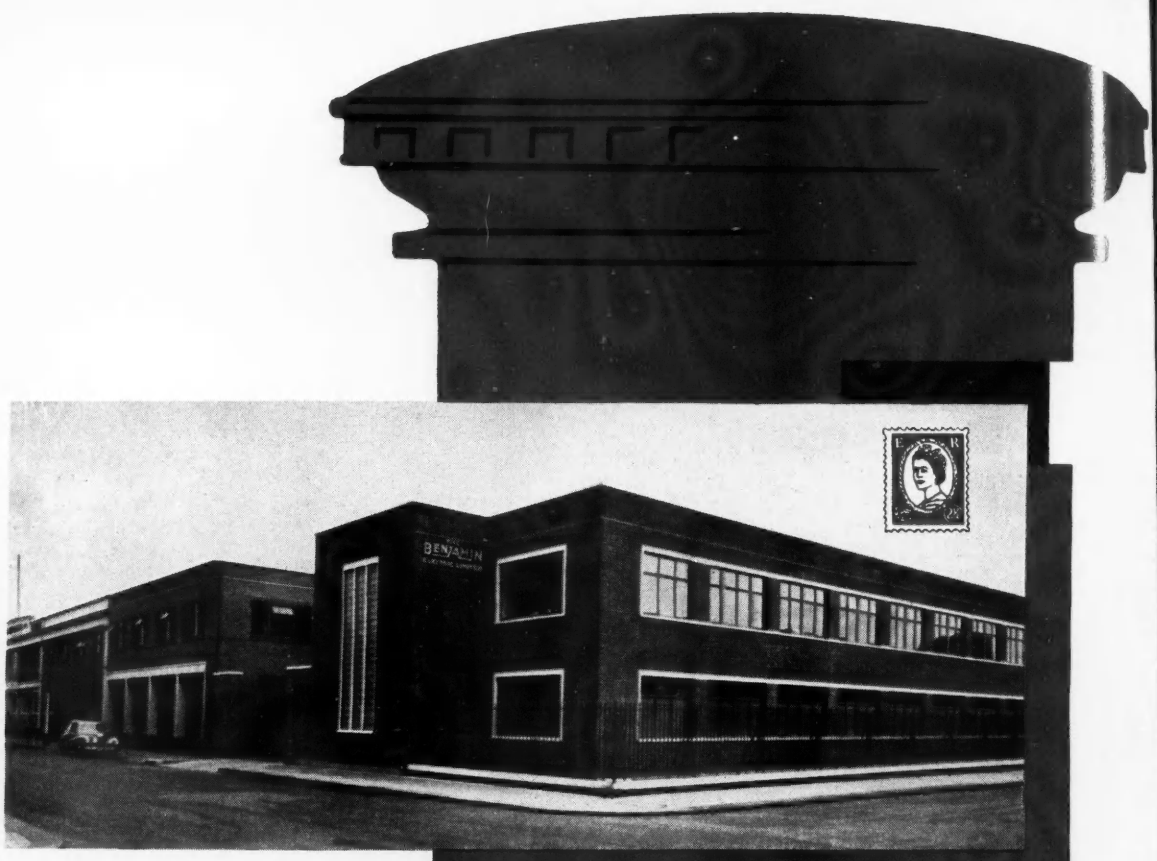


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# ELECTRICAL REVIEW

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13 APRIL 1956

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VOLUME 158 ◇ NUMBER 15

*Eighty-Fourth Year of Publication*

FRIDAY ◇ PRICE 1s 6d

101 *CLASSIFIED ADVERTISEMENTS*
114 *INDEX TO ADVERTISERS*

**Editorial, Advertising and Publishing Offices:** Dorset House, Stamford Street, London, S.E.1. Telegraphic Address: "Elecrev, Sedist, London. Code: ABC. Telephone No. Waterloo 3333 (60 lines). Registered at the General Post Office as a Newspaper. Entered as Second Class Matter at the New York, U.S.A., Post Office. Annual Subscription: Home and Overseas £4 10s 0d: U.S.A. and Canada $14.00. Cheques and Postal Orders (on Chief Office, London) payable to ELECTRICAL REVIEW PUBLICATIONS LTD., and crossed "Lloyds Bank."

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# Reactors and the Future

IN opening the discussion at the symposium of papers on nuclear energy presented at the Institution of Mechanical Engineers on 28th March Dr. Kay did well to stress that the large scale industrial development of nuclear power would be carried out in the main by ordinary engineers. The group of papers presented there and at the symposium held by the Institution of Electrical Engineers the following week were a real contribution to the understanding of nuclear engineering problems by engineers generally and put into everyday mechanical and electrical terms subjects which had hitherto been somewhat obscure.

These were the first detailed engineering papers to be presented in conjunction with the British Nuclear Energy Conference and from them there can be no doubt that the greatest problems to be tackled in harnessing reactor power lie in the field of heat transfer and the associated one of coolant heat capacity. Gas coolants involve high pressures to obtain heat capacity and high pumping power, thus lowering overall efficiency. Liquid metal coolants provide adequate heat capacity and require comparatively low pumping power but introduce complications because of greater induced radioactivity and the need for special metals for piping.

In the reactor core itself a high rate of heat transfer imposes severe temperature gradients on the fuel elements and their metallic sheaths and involves the possibility of damage due to these thermal stresses should a stoppage of any sort occur in the coolant circuits. For the same reason variations in temperature due to changes of output are undesirable and necessitate methods of control of the power plant as a whole to minimise "cycling." The problems to be solved in obtaining high outputs from the thermal reactors at present contemplated are indeed formidable but with the adoption of fast reactors and the use of a reactor core measuring only two feet square, such as that at Dounreay where the heat output from such a core will be 60 MW, the heat transfer system and its control present a far more difficult task. A working knowledge of how it is being approached is made clear from the symposia to everyone interested.

Research is in progress in Britain on the harnessing of the fusion process for power purposes but optimism in this direction, if successful control of the process is achieved, must be tempered greatly by thoughts of the heat transfer and metallurgical problems of temperatures in excess of anything that is yet known in engineering.

**B.I.F. ELECTRICAL EXHIBITS**

The British Industries Fair is being held at Olympia, London, and Castle Bromwich, Birmingham, from 23rd April to 4th May. Next week's issue of the *Electrical Review* will contain an illustrated preview which will constitute a guide to the electrical and allied exhibits at the Fair

## POWER FROM FUSION

The possible development of power from atomic fusion is mentioned in the last paragraph of our leading article. At the Conference on the Peaceful Uses of Atomic Power in Geneva last August much discussion was aroused by a prediction by the president, Dr. H. Bhaba (India), that within the next two decades means would be found of liberating atomic fusion energy in a controlled manner. Although Admiral Lewis Strauss, who led the American delegation, and Sir John Cockcroft (Great Britain) indicated at Press conferences that investigation of the possibilities of deriving power from atomic fusion were proceeding, they refused to commit themselves to any prophecies on the subject. Now it has been reported from Geneva that American atomic scientists have succeeded in devising a method of controlling fusion reaction and claim that power from this source will be available within ten years. A *Daily Telegraph* correspondent has also reported that progress in this direction is being made at U.K. Atomic Energy Authority establishments. The attraction of the idea lies in the cheapness and universal availability of the "raw material," hydrogen, but the nature of the problems associated with the elevated temperatures of the process (said to be of the order of 500,000 deg C) makes it difficult to accept claims of imminent success. That is not to deny that eventually means will be found of harnessing this cheap form of power.

## COMBINED OPERATION

Since India secured her independence British manufacturers have not enjoyed the measure of preference which prevailed in earlier days. At the same time Indian economic development is providing greater opportunities for industrial countries from which British concerns should benefit if they are able to make competitive offers. The way in which orders are being allocated by the Indian Government is illustrated by developments in the steel industry. A group of German firms, in which Krupps predominate, is erecting a large steelworks at Rourkela and the Russians have a contract for another at Bhilai. Now it has been announced that a British consortium consisting of a number of constructional engineers and makers of steelworks equipment, together with four of our leading electrical manufacturers, have contracted with the Government to build a works costing about £80 million at Durgapur, West Bengal. In all these contracts the financial aspect has been an important factor. In the British case, of the £52 million required £25·5 million will come from Indian sterling balances, £15 million will be provided under guarantee by the British Government and the rest will be raised in the City of London.

## UGANDA PROGRESS

The Uganda Electricity Board shows a satisfactory year's advance in its annual report, summarised in this issue. Plant installation has now far overtaken maximum demand and the fact that virtually three-quarters of the present available plant at Owen Falls is not yet usefully employed is bound to mean a major loss of revenue, which could be earned at negligible cost. Such an excess of plant over demand is not uncommon in pioneer electrical installations particularly those dependent on water power; the Board had planned to meet large factory power demands which have been considerably delayed. Proposals to start construction of further hydro-electric works on the Nile, below Owen Falls, as early as 1960, appear to be unduly optimistic about the growth of load. The report refers to the possibility of transmitting as much as 45 MW to Kenya by the 132 kV line just completed but one may justifiably wonder how long such a load will take to develop, when the present maximum demand in the three principal areas of Western Kenya is just 2,000 kW. The Nairobi area could certainly take more but it must be remembered that the distance from Owen Falls is 400 miles, a long way at 132 kV. Much will probably depend on the cost of raising capital in 1960, for the Owen Falls scheme was largely financed during a period of low interest rates.

## THE INDUSTRY'S FUTURE

In his speech at the annual meeting of Associated Electrical Industries, Ltd., last week, Lord Chandos, the chairman, was optimistic regarding the future of the electrical industry. He said that it seemed to the A.E.I. board that such enterprises as the chemical and electrical industries must be amongst the leaders in the latter half of the century, and he based this assumption on three main developments. Firstly, there was the construction of nuclear power stations, in which, he said, the cost of electrical devices for the reactor and of conventional electrical equipment (turbo-generators, switchgear and transformers) would be 40 per cent of the total; secondly, the future rapid growth of diesel-electric and electric traction in many parts of the world; and thirdly, the new uses for electronic apparatus which were constantly being developed. To say that we were standing upon the threshold, or perhaps had already passed the threshold, of a new industrial revolution was no catchword or cliché.

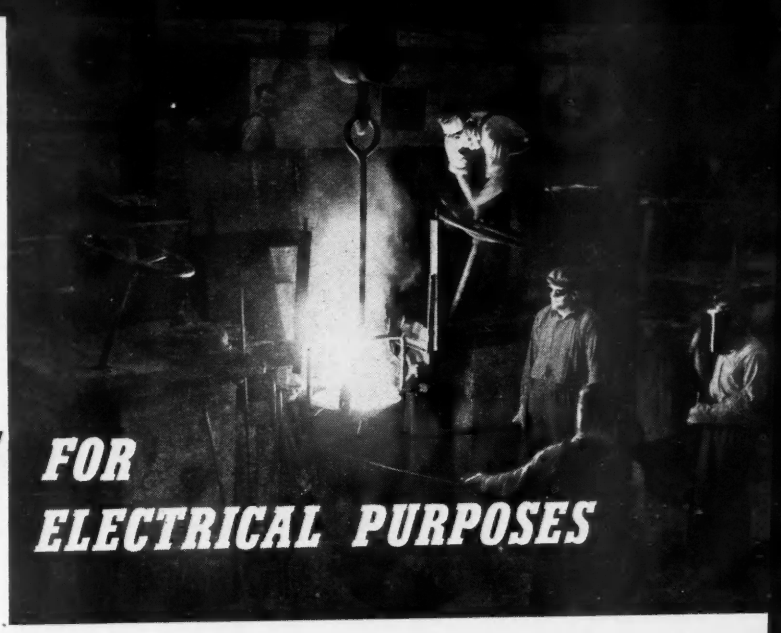
## COPPER VERSUS ALUMINIUM

A good deal of confusion appears to exist in the minds of electrical people about the respective claims for and predictions of the future of copper and aluminium in the electrical industry. By virtue of its superior conductance copper must continue to be superior in electrical performance. Despite this fact aluminium has won a high place for itself in such fields as overhead transmission and distribution where its lower weight is a considerable advantage.

In certain commercial fields it is being held that the future lies with aluminium in this country because we are losing control or are likely to lose control of copper supplies, whereas we are assured of supplies of aluminium because of the large developments in the Commonwealth in recent years. Again, it is claimed that aluminium lends itself to simpler and cheaper manufacturing processes; indeed our attention has been drawn to claims made along these lines as far back as 1910. We must say that in the few decades after that year those claims do not appear to have been fully substantiated. Our immediate interest, however, rests in clarifying this confusing issue and we hope some of our readers will be helpful in this respect.

PRODUCTION TECHNIQUES EMPLOYED BY BRITISH DRIVER-HARRIS

# NICKEL ALLOYS FOR ELECTRICAL PURPOSES



THE extensive and still expanding use of electricity has brought into being a growing demand for nickel and its alloys, and it is true to say that, apart from copper, nickel is the most important metal in the electrical field. It is difficult to think of an electrical application which does not utilise nickel or a nickel alloy in one form or another as an integral part. The diverse applications which present themselves have given rise to the need for a variety of alloys, each possessing special properties, such as electrical resistance, temperature coefficient, magnetic, expansion, and thermal e.m.f., to mention but a few. It should be pointed out that although certain long established alloys such as the nickel-chromium, copper-nickel, and nickel-iron types are still of major importance, new alloys, or modifications of the older ones, have had to be developed to meet the needs of new applications. This is particularly true in the case of the electronic industry and with the development and growth of this new aspect, it is to be expected that research into new and improved alloys will be an essential of the future.

In view of the foregoing it was with interest that we recently visited the Cheadle Heath works of the British Driver-Harris Co., Ltd., which specialises in the large scale production of this group of materials. The fields of application covered by this company's products include electric heating, radio, television, electronics, temperature measurement, and automobile and other specialised industries.

The company was originally founded by John Drennan and James Cooper in 1908 when Drennan and Cooper in association with a Mr. W. Glover started business as electrical agents, mainly in the cable trade, with an office and warehouse at the Corn Exchange in Manchester. Mr. Glover retired from the partnership at a relatively early stage, and Drennan and Cooper started manufacturing cable early in 1912 at Stretford just outside Manchester, trading as the North Western Cables Co. About this time Mr. Drennan first met Mr. F. L. Driver of the Driver-Harris Co., Harrison, New Jersey, and an agency with that company for the sale of " Nichrome " wires in Europe was established, although the first sales of " Nichrome " in this country had probably taken place before that date, one of the first known being to Mr. Archer of the General Electric Co., Ltd.

The firm of Drennan and Cooper left Stretford early in the first world war, and about 1915 they transferred their cable manufacture to larger premises at Gaythorn Mill, Albion Street, Manchester, to enable them to carry out the complete operation from raw rubber, cotton yarn, etc., to the finished and tested cables. This move also provided the accommodation necessary for the commencement of manufacture of " Nichrome " wires in this country, because at this very early stage, particularly under war conditions, it was realised that manufacture of this product in the United Kingdom was essential in the national interest.

In 1917 a limited company was formed under the style of Driver, Drennan and Cooper, taking over the business of Drennan and Cooper and the North Western Cables Co., in all its activities, the first chairman being Mr. F. L. Driver, Senior.

The first manufacturing operations were confined to the drawing of ¼in diameter rod down to finished sizes, but from the outset complete manufacture was always kept in view. First of all heat and corrosive resistant castings were made, after which 60/40 copper-nickel was introduced under the trade mark " Advance." These products were followed soon afterwards by " Nichrome," and at the same time " Nichrome III " and " Nichrome IV," and ultimately " Nichrome V " were made in the form of malleable ingots. Initially these were cogged on a steam hammer and hot rolled right throughout at Gaythorn Mill, Manchester, and progress towards a separate independent manufacturing unit was rapid.

In 1921 the title of the company was changed to its present style and land was purchased at Cheadle Heath. From the early 1920's up to the present day, manufacturing operations have been gradually transferred from Gaythorn Mill to the new site at Bird Hall Lane, Cheadle Heath, Stockport. This process has been greatly accelerated since the second world war, under the managing directorship of Mr. R. M. Parry and all the metallurgical work consisting of the manufacture from start to finish not only of " Advance " and " Nichrome," but the production of an extended series of old and new electrical alloys is carried on. The works at Manchester is now, as originally, entirely confined to the manufacture of cables, but it is anticipated that in the near future manufacture will be completely transferred to Cheadle Heath, leaving only an office in Manchester.

The works at Cheadle Heath has a total area inside the present boundary of 11 acres with a frontage of 400ft. Apart from the research and laboratory block, also the original general office block, all buildings at present in use are of single storey construction and in the main are steel

*Left: Roll cogging ingots down to 1 inch square bars. Right: The looping mill rolls bar down to 0·280in diameter rod*

framed structures with dwarf brick exterior walls, the upper and roof cladding being of corrugated sheeting. The total covered area is at present 84,200 sq ft, but additional buildings and extensions, now actually under construction and scheduled for completion during 1956 will add a further 9,750 sq ft. These developments include a two-storey block designed specifically to accommodate plant for the manufacture of plastic insulated cables, a two-storey extension to the laboratory/stores block to be used exclusively by the superfine wire and enamelling department, and an extension to the workpeople's canteen which will add a further 800 sq ft to the floor space available for this purpose.

During the past twelve months the company has completed an extension to the foundry building, which has enabled the reorganisation of this department to be commenced, and also the construction of a new high frequency generator house and transformer station. An additional bay, 190ft long by 40ft wide, has been added to the metal finishing department thereby providing accommodation for the wire test department, electrical and mechanical maintenance departments, and a raw material stores for the centralisation and control of all works stores. A loading bay has also been constructed alongside the finished material stores to increase the efficiency of loading and unloading of vehicles and at the same time provide weather protection. Finally, a comprehensive network of internal works roadways has been laid down so that all types of vehicles can gain access to any part of the works.

## Products and Applications

Before describing the production processes employed in the works it would be of interest to refer briefly to the various alloys produced and their main applications. The alloys used almost universally for electrical heating are the nickel-chromium and nickel-chromium-iron types. For the highest temperature applications (up to 1,150 deg C), the 80/20 alloy "Nichrome V" which has the highest resistance to oxidation is essential in order to ensure long life. An interesting point in this connection is that during the last twenty years or so, improvements in the alloy have brought about an increase in life, as assessed by the Bash and Harsch test of the American Society for Testing Materials, amounting to many times that of the earlier 80/20 alloy.

For the lower operating temperatures such as are encountered in domestic heating applications, either the 80/20, "Nichrome V" or the 65/15/20 "Nichrome" types are generally employed. Another alloy which is finding increasing applications in industrial furnaces where protective atmospheres are employed, is the 37/18 "Chromax" type, which has good resistance to atmospheres of a carburising nature.

In the radio and television fields, the valve industry consumes an appreciable tonnage of pure nickel and manganese-nickel, since almost all the metallic components in the radio receiving valve are of either of these two materials in wire or strip form. The growth of electronic devices embodying precision resistors of high ohmic value has brought a demand for fine and superfine wires of high resistivity and this is met by the "Nichrome V" alloy. In the case of resistors where constancy of resistance against temperature change is essential, this requirement is met by the new alloy "Karma" which is basically an 80/20 nickel-chromium alloy modified to produce a low temperature coefficient combined with a high resistivity.

Another important aspect in the radio and television field is the range of alloys for sealing into glass. Various alloys are used according to the type of glass involved, the ones finding the widest use being No. 4 alloy (42 per cent nickel, 5 per cent chromium, the balance being iron) for lead glasses; "Therlo" (29 per cent nickel, 17 per cent cobalt, with a balance of iron) for the hard glasses of the boro-silicate type; and the 48 per cent nickel-iron for soda glasses. The first two are extensively used for the sealed-in pins in moulded glass valve bases. Another alloy which is also used for this purpose with soft glass, although not containing nickel, is the 26 per cent chromium, 74 per cent iron alloy.

The importance of temperature measurement and control in industry is rapidly increasing and the thermocouple finds a wide range of application. The various thermocouple combinations can be roughly classified according to the maximum temperature of use, and in the base metal range, "Advance" (60/40 copper-nickel) with copper is suitable for use up to 400 deg C, and with iron up to 900 deg C. For higher temperatures of up to about 1,100 deg C increased resistance to oxidation is essential, and this is provided by the well established T1 (nickel-chromium) and T2 (nickel-aluminium) alloys. The positive arm is approximately 90/10 nickel-chromium, the negative arm being a nickel alloy containing manganese, silicon and aluminium. A couple not widely used up to the present time, consists of the 90/10 nickel-chromium alloy with the 60/40 copper-nickel alloy, which gives the highest e.m.f. output of the ordinary combinations available.

There are many other applications in which nickel and its alloys are used; it is difficult in a short article to

cover the whole field, but mention should be made of one or two of the more important ones. For example "Advance" is used extensively for motor starter resistances, rheostats and resistances of various types, instrument coils, and in the domestic field, for the heating elements of electric blankets. In the automobile industry a large tonnage of nickel alloys is used for the electrodes of spark plugs, the common alloying elements being chromium, manganese or silicon in varying proportions according to customers' particular specifications.

Finally, before leaving the subject of applications, mention should be made of the latest development in the products of the company, namely, that of the production of thermostatic bimetal strip. A full range of five or six types is available, which covers the requirements of all applications where bimetal strip is used.

## Production Processes

Turning now to the manufacture of all these different alloys, production begins in the melting department where at present there are three high frequency coreless induction furnaces each with a capacity of 400/500 lb. Within the next month or so additional new equipment including a motor-alternator and a 10 cwt furnace is to be put into commission. The melting techniques involved in all these types of alloys is critical and only long experience has enabled the company to produce the high quality alloys for which it is well known. To ensure the satisfactory casting of ingots careful preparation of ladles, ingot moulds etc., is essential. Experience and technical control is the hallmark of this section as in all others and control starts immediately from the intake of the raw materials to the final product leaving the warehouse.

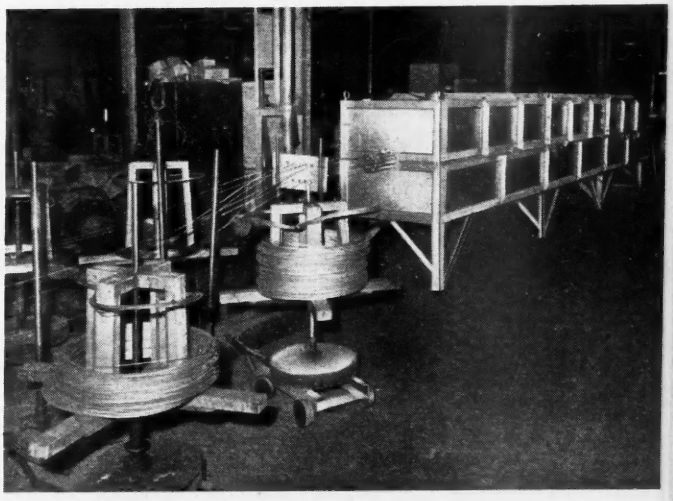
During the casting of the ingots a sample is also cast and both ingots and sample are stamped with an identification number which follows through the factory. The sample is analysed and the material is not further processed until approved by the laboratory.

The ingots next go for dressing, and this is done by turning down the rough surface on a lathe. After this operation the ingots are charged into oil-fired furnaces, and on reaching the desired temperature, which is very critical at this stage and varies according to the alloy, the ingots are reduced to about 1in square bars on a three-high 16in cogging mill, the main drive being a 550 h.p., a.c. motor, running at 600 r.p.m. The bars are then inspected after which they are charged into an automatically controlled gas fired furnace and rolled down to $\frac{9}{32}$in diameter rod on a three-high seven-stand 10in looping mill, the main drive being a 500 h.p. d.c., 475/950 r.p.m. motor fed by a 400 kW 480 V, 985 r.p.m. generator. This rod rolling operation is an art in itself and has only been developed after years of experience and like the cogging mill operation necessitates team work.

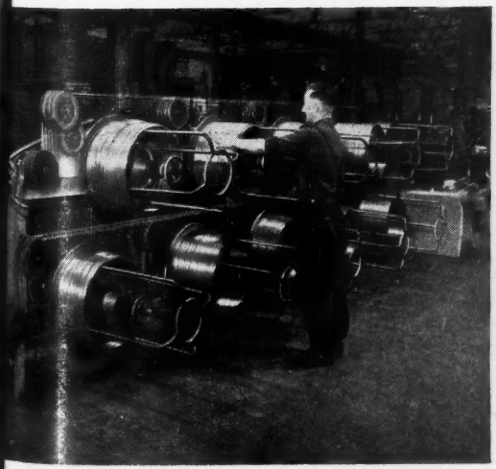
Provision is also made for the hot rolling of strip in various widths on both mills and here again the development of the correct reductions, especially in relation to the nickel-chromium types of alloy, are the result of practical operating experience. It is a fact that nickel-chromium is one of the most difficult alloys to process; other of the company's alloys such as "Advance," which is a 60/40 copper-nickel alloy, are straightforward and give little trouble.

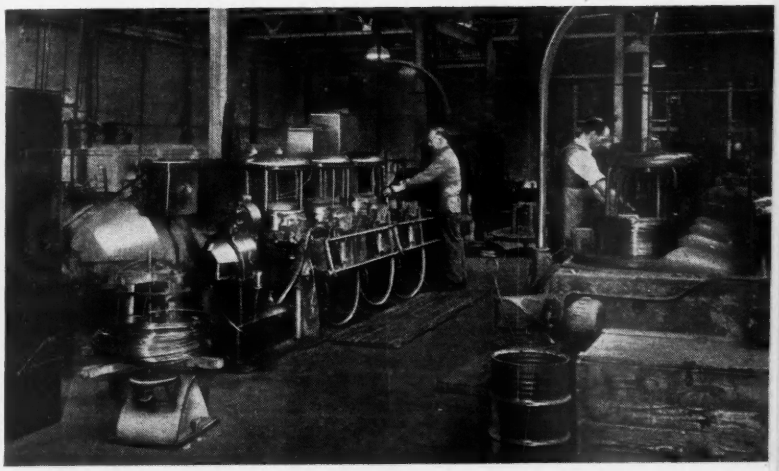
At the rod stage the material divides, nickel-chromium going for salt annealing, while malleable nickels and cupronickels go for bulk annealing in controlled atmosphere furnaces. These furnaces are of two types. In one case

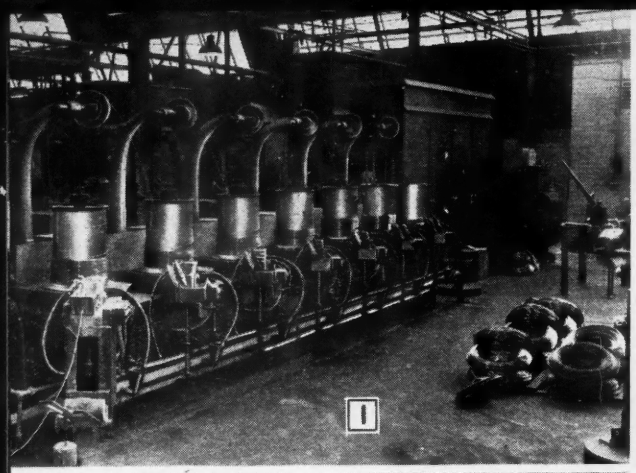
*Wire is annealed in this ten-tube 24ft long 45 [kW continuous annealing furnace*

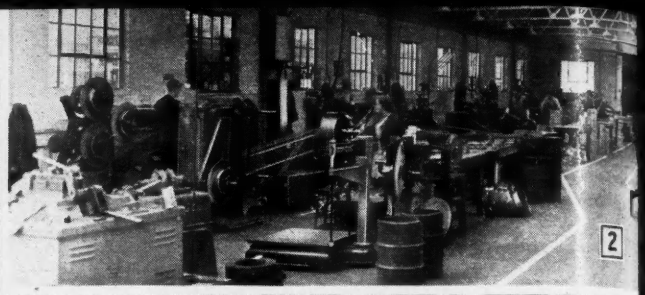


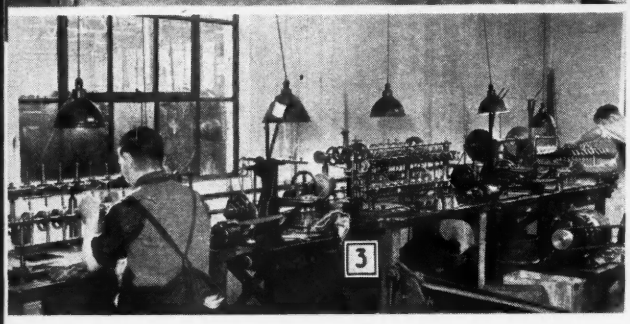
*Left: A section of the heavy wire department. Right: Take-up stand for the 24ft continuous annealing furnace*

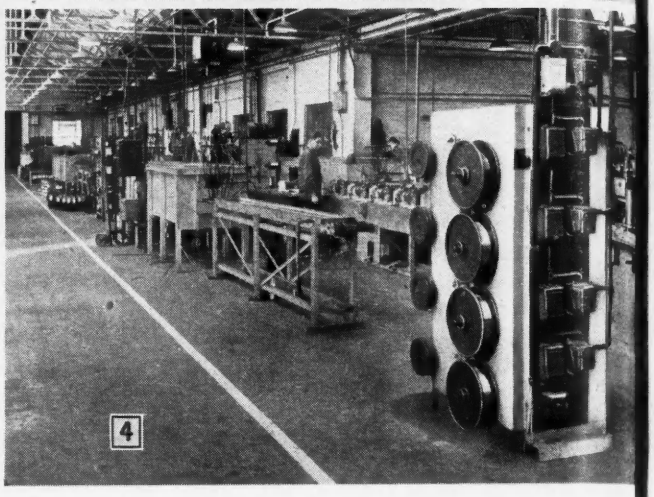








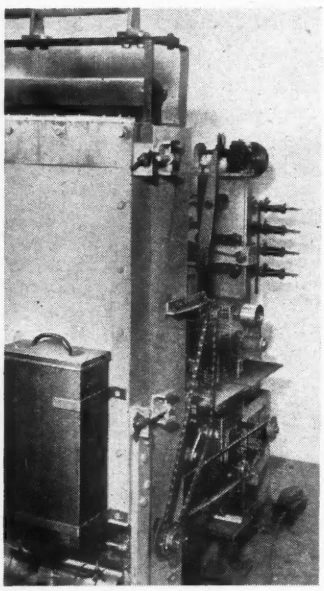




*(1) Drawing nickel-chrome wire on a seven-block machine. (2) Part of the cold rolling and slitting department. (3) A section of the diamond die servicing department. (4) General view of the continuous strand annealing equipment*

the charge is mounted on a static base and the whole is covered with a hood, purged with nitrogen and finally fed with cracked ammonia. The heating chamber is then lowered into position over the hood. The heating chamber weighs about 7½ tons, the loading being 120 kW. In the case of the other type of furnace the charge, after preparation, is lifted with the hood on a hydraulic ram into the elevated heating chamber, the loading being 60 kW.

All the annealing furnaces are fed with cracked ammonia, which is produced in the company's own centralised cracked ammonia station and piped around the factory, thus ensuring that an adequate supply of gas is maintained. The production of this gas is under close control and special steps are taken to ensure that the gas is pure before it enters the annealing furnaces or tubes as this is essential to produce bright annealed material. Some of this annealing equipment can also be used for open annealing to produce oxidised finished wire or strip.



*This equipment is used for enamelling superfine wire*

After the annealing operation both types of material, i.e. nickel-chromium, malleable nickels etc., go to the cleaning department for preparation prior to subsequent cold reduction. Here they are examined, acid cleaned and coated with drawing lubricant ready for further processing. This department is a good example of this type of plant, being fitted with the most up to date cleaning units and mechanical handling equipment, etc. The company has also gone to great lengths to keep the atmosphere as free as possible from fumes.

After preparation the material starts on the first stages of cold reduction. This is done by either of two methods depending on the finished product, i.e. if wire is required the material is cold drawn through dies, whereas if strip is being produced it is cold reduced by a series of rolling mills.

The reduction to wire is carried out on some of the most up to date equipment in the country and wire is eventually produced down to 0·0006in diameter. The four sections for drawing wire are concerned with heavy wire, medium wire, fine wire, and superfine wire respectively. An important factor in the development of the wire drawing section is the fact that the company has its own die department. Here the actual diamond stones are made into dies in a variety of sizes, down to 0·0006in bore. This department also deals with the re-servicing of all tungsten-carbide and diamond dies.

At certain stages during the cold reduction it is necessary to re-anneal or soften the material before further cold work can be done, the method adopted being either by continuous strand annealing or batch annealing.

The large continuous strand annealer is almost 24ft long with a loading of 45 kW, while the smaller strand annealers vary from 3ft to 15ft in length, the loadings being 4 kW to 18 kW, 230 V, balanced over three phases, all being temperature controlled.

These furnaces consist mainly of one type with from eight to ten annealing tubes per furnace, enclosed by "Nichrome V" heating elements which are supported in refractory tiles. The wire being annealed passes through these tubes, both the speed and temperature being carefully controlled.

During cold reduction to wire, tungsten carbide dies are

used at the initial stages but eventually diamond dies are used both for finished and some breakdown sizes. For example, the nickel-chromium alloys are drawn with a metal coat to 0·1in diameter and after removal of this drawing coat the material is reconditioned by continuous strand annealing and again metal-coated for drawing to 0·032in diameter through tungsten carbide dies. After again removing the drawing coat the material is re-annealed and coated with drawing lubricant and drawn to finished sizes through either tungsten carbide or diamond dies.

In the cold rolling department strip from $3\frac{3}{8}$in wide and thicknesses in some special instances down to 0·002in is processed on a series of mills. Ribbon or flat wire production is also a speciality of this section, this particular item having to be produced and despatched to exacting tolerances.

During the last twelve months an entirely new section has been added to the cold rolling department for the production of thermostatic bimetal. This material demands the most up to date equipment, which includes precision multi-slitters, edging and straightening plant, etching equipment and numerous other items.

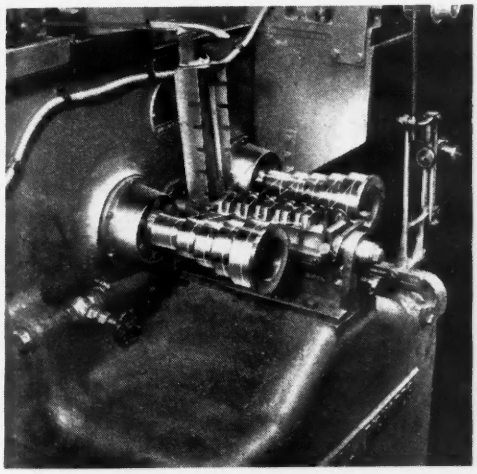
Moving back again to the wire side, mention should be made of one or two particular developments that have come about in the last year or so. These in particular are the production of fine and superfine wires. The section for this work is equipped with modern wire drawing plant of the multi-die pattern together with specially designed winding equipment necessary for the precision production of wire down to 0·0006in diameter. Within the next few months or so a new building will be completed to re-house this continually expanding section and to provide accommodation for a new development, the enamelling of fine and superfine wires.

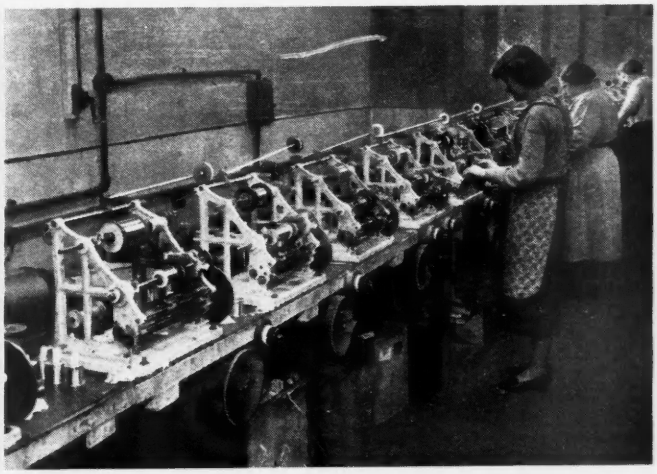
Finally, we come to the shipping department and this again is housed in a modern building and works in conjunction with the company's own fleet of lorries and vans. This arrangement ensures a quick and reliable flow of material to customers in any part of the country.

## Testing and Inspection

All goods sent out are subjected to inspection by a highly experienced technical department, this work being one of its most important activities. In the test rooms, visual examination of surface and winding of all wire and strip is carried out; most of the wire and strip is resistance tested and on most sizes of " Nichrome " wires a spiralling test is included. Final inspection is carried out later, prior to despatch and includes cross checking of any or all of these properties.

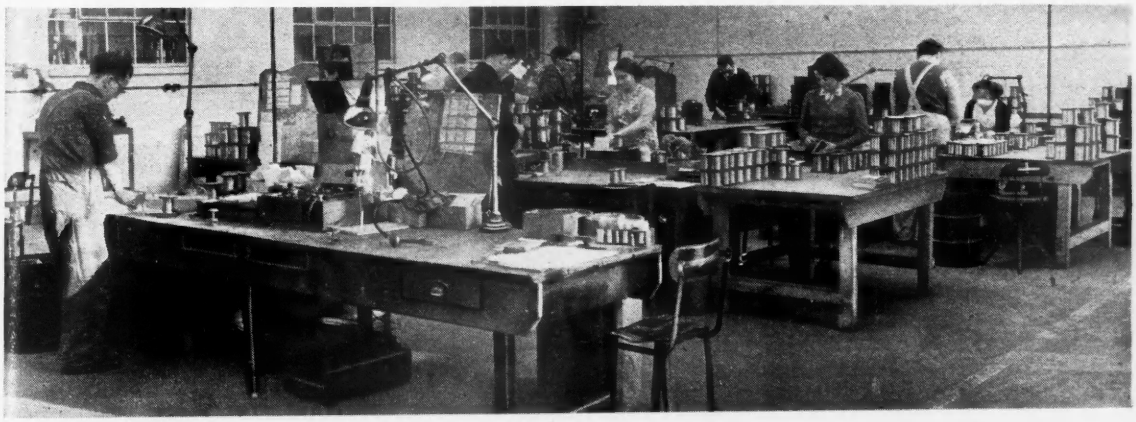
A high standard of quality is maintained. The life testing of nickel-chromium alloys is pursued regularly and without interruption, the samples being taken at any stage in the process from the melting furnace to finished wire





*Left : Close-up of one of the superfine wire drawing machines.* *Right: Automatic superfine wire spool winding takes place on this bank of machines*

*A section of the testing and inspection department*

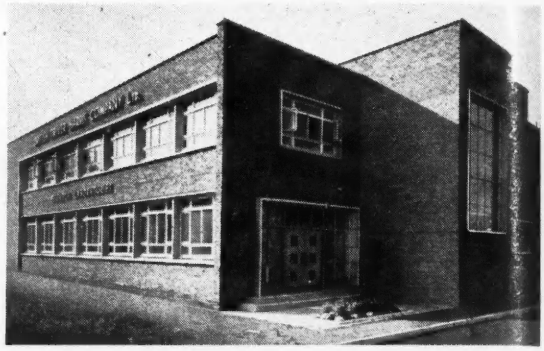


in stock. Mechanical and other properties such as temperature coefficient, grain size, thermal e.m.f. etc., are tested regularly and when specifically mentioned in an order, they are given particular attention.

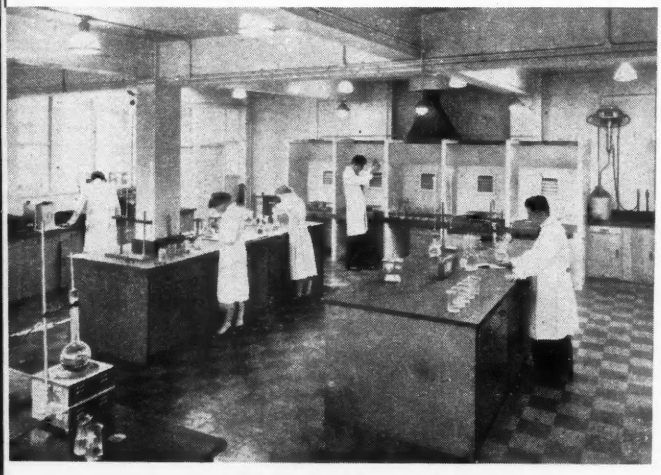
In view of the rapid increase in demand for nickel alloy products since the war and the ever widening scope of applications a new laboratory and research department was completed in 1954, to accommodate not only the normal routine testing but to provide research facilities for the development of new and improved materials. This building is a two-storey structure having about 6,500 sq ft of floor space.

The work of the laboratory as a whole falls into three categories: routine production control, research and development, and technical service. Under the first heading chemical and spectrographic control of both incoming raw material and also all melts of the various alloys made involves on average some thousands of determinations each month. A check is maintained on physical and mechanical properties at various stages during manufacture as well as ultimate testing of finished material according to customer's specifications. Life tests on production heats to check quality of resistance wires are also made.

In research and development close collaboration is maintained with the works for the development of new alloys and improved techniques of manufacture and also in the investigation of works problems. Finally, the laboratory works closely with the technical service department in the investigation of customers' problems concerned with the usage of nickel alloys.

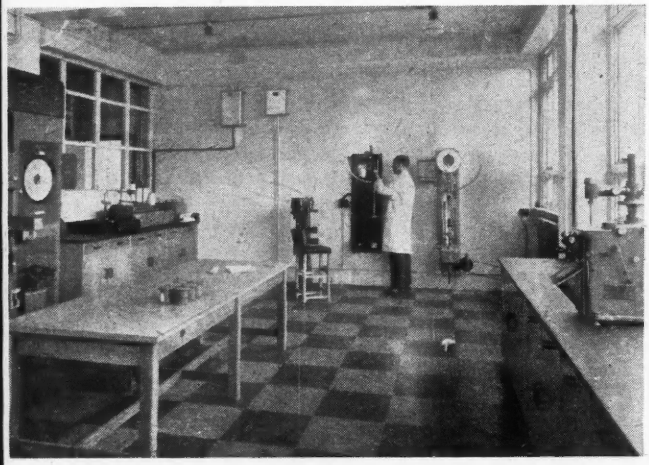


*The new laboratory and research department building*



*General view of the chemical department*

*Part of the physical and mechanical testing department*



The chemical and spectrographic laboratories are equipped with modern apparatus for chemical analysis of metals and a large Hilger quartz spectrograph and microphotometer. An adjacent dark-room with thermostatic temperature control contains automatic developing equipment to facilitate more accurate and rapid determinations. The physical testing laboratories undertake tests for resistivity, temperature coefficient of resistivity, temperature coefficient of expansion, thermal e.m.f., deflection constants and torque of bimetals, mechanical testing on a range of machines covering sizes from $\frac{3}{8}$in rod down to 0·0006in diameter wire, macro and micro hardness, and deep drawing and temper properties.

The metallographic laboratory is equipped with a high speed cut-off wheel, grinding and polishing machines and mounting press for sample preparation, Leitz microscope and Vickers projection microscope for metallographic examination and photographic recording of microsections. Bench microscopes for routine examination of wire and strip for surface defects, and furnaces for experimental heat-treating and the study of behaviour of metals in various atmospheres are also installed.

A bank of test heads designed and built by the company is in constant service for the life testing of resistance wires by the A.S.T.M. (Bash and Harsch) standard procedure. This is used not only for routine production control but for the development of new and improved high temperature alloys. In the latter connection an experimental melting department has been included which is equipped with a 35 kVA coreless induction furnace of the mercury spark gap type having a melting capacity of approximately 20 lb.

The thermocouple testing department undertakes the routine checking of thermal e.m.f. of all coils and spools of thermocouple material before leaving the works.

## Power Supply Arrangements

The electricity supply for the works is taken at 6·6 kV from the North Western Electricity Board to No. 1 works substation in Bird Hall Lane at the northern corner of the works site. The 0·25 sq in three-core incoming feeder cable terminates in a six-unit horizontal draw-out metalclad main switchboard installed in the substation adjacent to the existing high frequency generator house and melting department. In the same substation are two step-down transformers of 750 kVA and 200 kVA rating respectively, which provide the 400/440 V supply to the two 100 kVA and one 125 kVA high-frequency generators; each of the

latter has a 2,250 c/s 800 V output. Recently, a third transformer of 350 kVA rating has been installed and it is connected by h.v. link cubicle into the same feeder control unit as the 200 kVA transformer, thus providing the supply necessary for a new 300 kW water-cooled high-frequency generator, which will be commissioned during the next few months.

Considerable reorganisation of the melting department and foundry has been possible since the completion of the extension, and the melting capacity will be materially increased by the introduction of the new 10 cwt high frequency coreless induction furnace equipment. The full scheme will include the renovation of the low voltage power distribution throughout this building. During the early part of last year the 5 ton e.o.t. crane was fitted with a new crab and electrical control gear, the speed of the hoist motion being doubled.

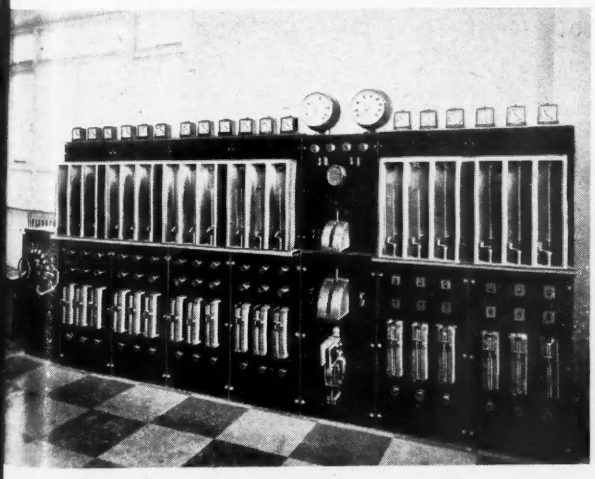
There are at present three step-down transformer substations throughout the works, connected by means of h.v. underground radial feeder cables to individual units on the main switchgear. A fourth transformer substation, which also includes a motor generator set (output 83 kW at 250 V) to provide a d.c. supply for the heavy wire drawing department, receives a 6·6 kV supply by an extension feeder from substation No. 2, in the medium wire department.

The h.v. feeders to both the rolling mill substation No. 3 and the metal finishing department substation No. 5 have been so designed that as development of the southern half of the site progresses an internal h.v. ring main can be established through future substations No. 6 and 7 and multi-way underground earthenware ducts have already been installed to accommodate the initial portion of this section of the h.v. distribution scheme.

The latest, No. 5, substation, established in 1952, has a present capacity of 500 kVA, but provision has been made for this to be increased to 750 kVA. An open-type h.r.c. fused distribution equipment is installed in this substation and already a further three 300 A outgoing feeder units have been added to the three originally installed. The h.v. supply to the transformer is controlled by a single metal-clad unit with an off-load oil-immersed isolator on the incoming feeder, there being provision for a second isolator for the future ring main. Cubicle type switchgear is installed in all other transformer substations, and combination fuse switchboards are used to initiate the l.v. power distribution in the various departments.

Apart from the high frequency coreless induction furnace load mentioned earlier, the cogging mill and looping mill with 550 h.p. and 500 h.p. main driving motors respectively, constitute the heaviest consumers of electrical power. In addition heat treatment in the form of electrode salt baths (165 kW and 125 kW), bell annealing furnaces (2-60 kW and 1-120 kW), and wire strand and strip annealing furnaces provide a relatively high load factor.

*Bank of test heads for carrying out Bash and Harsch life tests*



Under the heading of works services there are two very good illustrations of ways in which electrical power can be used to improve existing methods. In one case work has commenced on the bore of a 12in diameter deep well, from which it is anticipated that by means of a submerged electrically-driven unit water will be pumped at a rate of 12,000 gal/hr. A reinforced concrete elevated water storage tank of 50,000 gal capacity is to be erected over the borehole, and pumping will be controlled automatically by the level of water in the tank.

In the other case the existing Lancashire boiler installation will later this year be replaced by a fully automatic oil-fired boiler incorporating both electronic and thermal control to obtain the maximum efficiency possible irrespective of load fluctuations.

NOTE: "Advance," "Chromax," "Karma," "Nichrome" and "Therlo" are registered trade marks.

## Russians Inspect A.C. Traction

FIVE Russian engineers on a visit to this country were recently invited by British Railways to inspect the Lancaster-Morecambe-Heysham electrification scheme, for which the main contractors were British Insulated Callender's Cables, Ltd. (a ¾-mile stretch of 20 kV overhead line) and the English Electric Co., Ltd. (electrical equipment for three three-coach units and substation equipment).

In view of the recent decision of British Railways to adopt 25 kV 50 c/s for traction purposes the Lancaster-Morecambe-Heysham line is of considerable interest. Each of the three trains on the line has satisfactorily covered 50,000 miles per annum since the experimental high-voltage a.c. system was put into operation just over two years ago. We had the pleasure of inspecting the scheme with the Russian engineers last week and they showed great interest in everything they saw. We gather that there is a similar experimental stretch of line in operation in Russia, although they have not so far built germanium rectifier equipment for traction purposes.

Apart from the B.T.H. germanium rectifier locomotive we also saw some new English Electric rectifier equipment which has recently been approved by British Railways. It is about 2 tons lighter than the original equipment and is designed to fit beneath the floor of a standard British Railways underframe. A newly designed air-cooled single-anode continuously-excited mercury arc rectifier is used to convert the a.c. from the transformer to d.c. for the four traction motors which are connected in series in pairs. Each motor circuit is fed by two rectifiers which are connected in bi-phase, each pair of rectifiers being mounted, with cooling fan and motor, heaters, and rectifier auxiliaries in an undercar case. The shell type transformer is designed to fit beneath the longitudinal centre member of a standard underframe. The reactors are oil cooled and mounted in one tank which is connected with the oil-cooling circuit of the main transformer. The d.c. circuits of the original equipment contained resistance notches to reduce the number of transformer tappings. The new equipment, however, has fewer tappings and no resistances are used, so that any notch can be used for continuous running.

After inspecting the track between Lancaster and Morecambe and seeing the trains and their electrical equipment in Morecambe station, the Russian engineers travelled to the Preston works of the English Electric Co., Ltd., where they saw electric locomotives and diesel-electric locomotives being constructed for service in many parts of the world.

# NEW BOOKS

**Factory Electrification.** By F. T. Bartho, Associate I.E.E., M.Inst.W., and C. H. Pike, A.M.I.E.E. Pp. 398; figs. MacDonald & Co., Ltd., 16, Maddox Street, London, W.1. Price 35s.

In spite of its comprehensive title, the scope of this book is limited, largely one might say to the activities of the power contracts department of a well-known manufacturer, illustrations of whose products appear prominently. The book may roughly be divided into two sections, one-third covering transformers, switchgear and cable systems and the remaining two-thirds motors and motor starters. Among the items omitted are factory main lighting and emergency lighting, electric welding, lifts and hoists, electrical heating and furnace equipment, telephones and public address apparatus, all of which fall within the activities of the factory electrical staff.

It is difficult to decide upon the type of reader to whom this book is addressed. While much of the subject matter is elementary, one finds elsewhere quotations in extenso from British Standards such as B.S. 116 which imply an understanding of such terms as asymmetrical breaking current and kindred matters out of keeping with the technical level of the remainder. The advice that "typical daily load curves should be prepared to show the probable power demand . . . before consideration can be given to the design and layout of a factory distribution system" is difficult to follow and such remarks as the recommendation to "utilise to the utmost water power where available provided the cost of civil engineering work is not excessive" could well be omitted.

As a manual of electric motor practice the book could be quite useful, especially as it contains comprehensive chapters on bearings and mechanical power transmission. While not disagreeing with the statement by the authors that "in general to ensure reliable operation, the rated symmetrical breaking capacity [of circuit-breakers] should be equal to or greater than the symmetrical short-circuit current" we do not agree that it is usual for a h.v. supply to be given for loads in excess of 50 kVA and would say that in our experience the normal limit is appreciably higher. The book is well produced and profusely illustrated but for what it contains it is somewhat expensive.—C.M.J.

**Electric Motors and Controls.** Pp. 278; figs. British Electrical Development Association, 2, Savoy Hill, London, W.C.2. Price 9s.

This is the third book in the series which has been produced to deal with industrial applications of electricity. The publication is timely in view of the reports of the teams that have been studying American methods. These indicate that one reason for the relatively high productivity of the American worker is the fact that the horse-power used per worker in America is at least twice that used in this country. The purpose of this book is to provide a review of the applications of electric motors and control gear and to assist users in selecting the correct type of gear.

The book is, therefore, free from highly technical matter which is of interest to a designer or a repairer, and includes only an elementary description of the principles of motors. This treatment enables a very wide field to be covered. There are chapters on d.c. motors, all types of a.c. motors, control equipment, automatic control, motor enclosures, mechanical power transmission, economics of motor operation, installation and care of motors and control gear. In each chapter all aspects of the subject matter have been considered which may be of interest to a motor user, such as starting, reversal, speed control, motor characteristics, braking, high-frequency and f.h.p. motors, timing gear, power factor improvement, electronic control and selsyn control systems. Of particular interest are the large number of illustrations showing the ways in which electric motors and control gear are used on a wide variety of drives from steel strip mills to sewing machines.

The book is written so that it is understandable by persons who have not studied electrical engineering, and consequently can be highly recommended to managers, executives and mechanical engineers who are concerned with production. In addition it provides a concise book of reference for students and electricians.—J.L.W.

**Electrical Engineer's Reference Book.** Edited by E. Molloy and M. G. Say. Pp. 2,184; diagrams, 2,959; photos, 281. George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2. Price 70s.

The eighth edition of this work follows the general plan of its predecessors in dealing with the theoretical and applied aspects of branches of electrical engineering (excluding radio and telecommunications) in 32 sections compiled by 71 contributors. New articles on major revisions of some earlier articles to take account of recent developments have been incorporated. These include: nuclear power for electricity generation with descriptions of various reactors now being investigated as well as those actually under development in Great Britain for earlier use on a commercial scale; gas turbines; mining applications; metal rectifiers; rotating amplifiers; the 13th (1955) edition of the I.E.E. Wiring Regulations; earthing; new materials; arc extinction; motors as affected by B.S. 2613 : 1955; and education and training. Statistics of generating plant planned by the C.E.A. up to and including 1959 are amplified by particulars of construction in the "Progress" section, which has once more been rewritten to describe new introductions of importance.—C.O.B.

**Kempe's Engineer's Year Book (1956).** Edited by C. E. Prockter, M.I.E.E., M.I.Mech.E., under the direction of B. W. Pendred, M.I.Mech.E. 2 Vols. Pp. 1,345 and 1,419; illus.; index. Morgan Bros. (Publishers), Ltd., 28, Essex Street, Strand, London, W.C.2. Price (2 vols. in case) 75s.

The 61st edition of this handbook contains much new matter to keep it abreast of recent developments. Of chief electrical interest are additions to data on cables, meters, carbon brushes and standard electric motors and on non-linear conductors (transistors). Further information is also given regarding steam practice, such as feed-water treatment (ion-exchange process) and on the twisting of long turbine blades.

**Mechanical World Year Book, 1956.** Pp. 360; illus. 4s 6d. **Mechanical World Electrical Year Book, 1956.** Pp. 360; illus. 3s 6d. Emmott & Co., Ltd., 31, King Street West, Manchester, 3.

The most notable new feature of this year's edition of the first-named reference book is a section offering a more advanced treatment of gas-turbine design in relation to modern practice; this presents data and detailed methods for use in dealing with the principal components.

Its electrical companion includes a new section giving a concise account of electronic fundamentals and methods. Under the heading of electric lighting, fresh matter has been introduced on the quick-starting fluorescent lamp with information on circuits and dimming arrangements.

## BOOKS RECEIVED

**Plastics Progress 1955.** Edited by Philip Morgan, M.A. Pp. 432; figs. Iliffe & Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 50s.

**Applied Electricity.** By A. W. Hirst, M.Sc.(Eng.), M.I.E.E. Third edition. Pp. 398; figs. Blackie & Son, Ltd., 17, Stanhope Street, Glasgow, C.4. Price 25s.

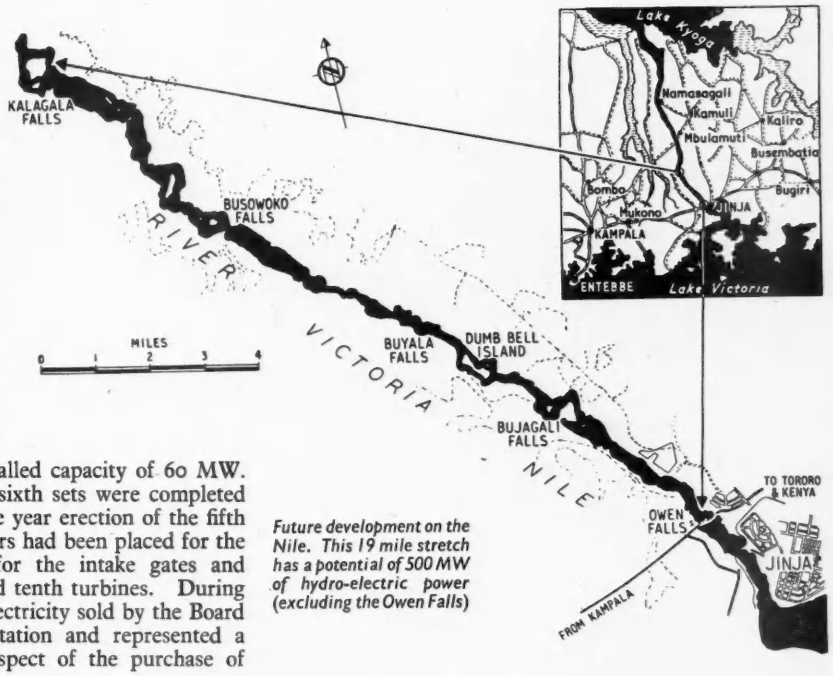
**Principles and Practice of Radar.** By H. E. Penrose and R. S. H. Boulding, O.B.E., B.Sc., A.C.G.I., M.I.E.E., A.M.I.Mech.E., F.Inst.P. Fifth edition. Pp. 795; figs. George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2. Price 50s.

# Uganda Electricity

## *Further Hydro-Electric Surveys*

THE Uganda Electricity Board recently published its eighth annual report and accounts, for the year ended 31st December last. The year saw the retirement of Sir Charles Westlake from the chairmanship of the Board; his successor, Mr. W. D. D. Fenton, was formerly deputy chairman of the Uganda Board and until quite recently secretary and commercial engineer, North of Scotland Hydro-Electric Board.

During the year the third and fourth 15 MW sets in the Owen Falls hydro-electric station were brought into commission, making a total installed capacity of 60 MW. Spiral casings for the fifth and sixth sets were completed and tested and by the end of the year erection of the fifth turbine had been started. Orders had been placed for the seventh and eighth sets and for the intake gates and embedded parts of the ninth and tenth turbines. During the year 99·53 per cent of the electricity sold by the Board was generated at this power station and represented a saving of over £400,000 in respect of the purchase of fuel oil.




*Future development on the Nile. This 19 mile stretch has a potential of 500 MW of hydro-electric power (excluding the Owen Falls)*

The main civil engineering works of the scheme were substantially completed and the final raising of the water level in Lake Victoria gave an operating head of about 59ft on the turbines. As a result, the historic source of the Nile, the Ripon Falls, disappeared.

During the year over 79 million kWh was generated at Owen Falls: this compared with the total of 16·4 million kWh generated in Uganda only five years ago. The maximum demand was 15,600 kW and the average load factor 58·3 per cent; 14,550 consumers are now connected to the Board's system.

Surveys of 19 miles of the Nile below the Owen Falls were completed during 1955 by the consulting engineers, Messrs. Kennedy & Donkin, and Sir Alexander Gibb & Partners. These showed that there is an additional potential output of some 500 MW in this stretch of the river. The additional power could be developed in two or three stages and if three new dams and power stations were constructed the first would have a firm output of 750 million kWh annually. At present-day price levels the estimated cost would be rather less than that of the Owen Falls scheme for a similar capacity. The date of starting any such construction would depend on the growth of use in Uganda, the requirements of Kenya, and railway electrification. It is anticipated that a start might be justified by 1960. In this context it is worthy of note that the year saw the signing of an agreement with the Kenya Power Company providing for a supply of electricity from Uganda to an ultimate total of 45,000 kW. Surveys were also undertaken of local hydro-electric resources in other parts of the country.

During the year the first 132 kV transmission lines were completed although these are not yet energised at full voltage pending the completion of the appropriate sub-stations. Some 90 miles of 33 and 11 kV overhead lines for distribution purposes were completed.

The total capital expenditure incurred by the Board up to 31st December amounted to £20½ million, of which £12¼ million was for the Owen Falls scheme and £4¼ million for transmission and distribution. The total of approved expenditure to the end of the year was £24½ million and the Board sought an increase in its authorised borrowing powers from £26 million to £35 million. Income for the year, almost entirely from the sale of energy, amounted to £748,388 and there was a surplus on the year's working of £1,170.

The Board's staff now numbers 1,814, made up of 186 Europeans, 86 Asians and the remainder Africans. One of the most urgent tasks confronting the Board is the training of Africans for more responsible positions, such as professional engineers, foremen and skilled workmen. Although many Africans have obtained university degrees in order to follow other professions there is a serious lack of African engineers. During 1955 the Board approved an apprenticeship scheme for the training of workmen and this was started in September with fourteen Africans under instruction as linesmen, cable jointers and electrical fitters.

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### Synthetic Rubber Production

Raw materials for the production of synthetic rubber are to be produced at a plant to be erected by the Esso Petroleum Co., Ltd., at Fawley, Hants, at a cost of £9 million. *The Times* says that butadiene from this plant will be fed into a £5 million factory to be built on an adjacent site by the International Synthetic Rubber Co., formed by the Dunlop company.

# LETTERS TO THE EDITOR

*Letters should bear the writers' names and addresses, not necessarily for publication. Responsibility cannot be accepted or the opinions expressed by correspondents.*

## Earth Loop Testing

IN the thirteenth edition of the I.E.E. Regulations for the Electrical Equipment of Buildings certain statements are made regarding the impedance of the earth loop and its measurement. Regulation 507 states that " each final sub-circuit shall be tested by means of an earth fault loop impedance tester of the current injection type." The note attached to this regulation states:—

> " The plug or terminal of the tester should connect it to the neutral and earth points, so that injected current (at a voltage not exceeding 40 volts) traverses the loop formed by the earth return path, the earthing point of the supply neutral and the neutral conductor. It is preferable for the current used in the test to approach 1½ times the rating of the sub-circuit, but in no instance need it exceed 25 amperes. The ratio voltage/current may be taken as the total earth-fault-loop impedance."

An important point to note in connection with this is that the neutral conductor is included in the circuit measured. This will extend back to the substation and will be shared by a number of consumers. As a result of this the neutral will already be carrying a current, which in some instances may be considerable. The passage of this current along the neutral will give rise to a voltage drop along it and this will manifest itself as a voltage between the neutral conductor and earth. This voltage has been recorded by a recording voltmeter in a number of places, with rather surprising results. The actual voltage may reach quite high values, 15 V has been noted, and not only this, it is varying continuously and rapidly. It is reasonable to suppose that not only the magnitude, but the phase is varying as well.

If now an attempt is made to measure the loop by the method suggested in the regulation, or in fact by any method which draws its testing current from the supply, steps must be taken to neutralise the effect of this continuously and rapidly varying voltage drop, as otherwise no sensible results can be obtained. This is a very difficult matter, and no instrument so far suggested, which draws its testing current from the mains, is free from error on this account. Investigations both theoretical and practical have shown that these errors may amount to 100 per cent or even more.

A second point which requires attention is the value of the testing current. The regulation requires a current 1½ times the rating of the sub-circuit, and while this is desirable to check the ability of the circuit to carry fault current, it is not necessarily the best value to give information of the state of the circuit. In earth continuity circuits there are often clamped joints, such as an actual clamp round a water pipe, and it is not at all unusual for a badly conducting film to form in such a joint. If now a test is made with an instrument having a low internal impedance, practically the whole of the testing voltage is applied to the bad joint, which breaks down and allows a heavy current to pass and the circuit is passed as satisfactory. If on the other hand, the instrument has a high internal impedance so that it can only pass a comparatively low current, the voltage applied to the bad joint is low, it does not break down, a low current passes and a high resistance is recorded.

In order then to carry out a satisfactory test it is advisable to make measurements first under conditions such that only a low current can pass and secondly such that a high current can pass. If the impedance values are practically the same, then the circuit can be considered satisfactory as regards joints in the earth continuity conductor and the value obtained can be taken as that which the loop will have if a fault occurs. If, however, the value obtained with the higher current is considerably lower than that with the lower current, then this is an indication of bad joints in the circuit which should be examined further.

A third point is the question of " impedance " instead of resistance. The specification of impedance presupposes that the circuit contains reactance which in this case would be inductive. The only parts of the circuit which might contain inductance are the earth continuity conductor and the neutral conductor, but it is very doubtful if, in practical cases, the amount of inductance present is sufficient to produce any significant difference between the resistance and the impedance of the circuit. Measurements made on several loops tend to confirm the idea that the loop can be treated as a resistance only.

An ideal instrument should give the correct value, independent of a continuously and rapidly varying voltage drop in the neutral conductor; and possess facilities for making tests at low currents (milliamps) and high currents (amps) in order to detect faulty joints, etc. In addition, it is sufficient if the instrument measures resistance instead of impedance.

*Chiswick.*

G. F. TAGG, B.Sc., Ph.D., M.I.E.E., F.Inst.P.,
*Chief Research Engineer,*
Evershed & Vignoles, Ltd.

[A description of such an instrument as that mentioned, produced by Dr. Tagg's company, appears on page 583 of this issue.—*Editors.*]

## C.E.A. Network Analyser

YOUR description of the network analyser of the C.E.A. Southern Division at Portsmouth was of great interest. It is unfortunate, however, that the C.E.A. carries out such work on its own and without consultation or co-operation with specialist manufacturers. Without such co-operation, it is difficult to gain the necessary experience to venture into the considerable export market for a.c. network analysers.

The fact must be faced that while much of the basic work on large-scale aids to power system study, planning and operation is carried out in this country, export orders for such aids are placed entirely with firms abroad. The attitude of the C.E.A. is largely responsible for this state of affairs.

May I also draw attention to the irresponsibility of quoting a price for such a large equipment which bears no relation whatever to cost. Design costs, supervision, testing and all overheads have been conveniently "hidden." War surplus materials have been used where possible. The use of 2 per cent tolerance components is of doubtful advantage, even from the narrowest cost angle.

The danger of this is to give an entirely false picture of the cost of a.c. network analysers. The immense saving in scarce manpower and the frequent saving in very expensive transmission equipment are such as to pay for the real cost of even a large a.c. network analyser in a

short space of time. No advantage is therefore gained by quoting prices which bear no relation to the real cost. Whether such cost is higher when equipment is constructed by a specialist manufacturer rather than by a national supply authority is open to serious doubt.

*Newcastle-upon-Tyne.* H. LOEBL,
*Managing Director,*
Power System Computors, Ltd.

### British Industries Fair

I AM very interested to read in to-day's *Electrical Review* your article on the last B.I.F. in London. We of the Electrical Exhibitors' Committee, of which I have the honour to be chairman, feel that the Minister's statement has been grossly mistimed, and in fact, condemns the London B.I.F. to failure before the final one is held.

We feel that this will have an adverse effect on would-be buyers for this year's Fair, and seeing that the majority of overseas buyers travel by air, and would, therefore, not have started out on their journey at the time of the Minister's announcement, the chances are that a number of them will think the Fair is not worth while seeing, and will accordingly cancel their passages.

As you correctly state at the end of your article, the main Electrical Section was transferred to London as we felt there was a better opportunity of being visited by buyers, particularly overseas buyers, than has been the case in Birmingham. After all we are asked by the Government to increase our export trade and, of course, our move to London is partly tied up with this problem.

Although B.E.A.M.A. were largely instrumental in the move from Birmingham to London, I understand that they were not consulted in any way, although the Minister states that the fullest consultations took place with the Federation of British Industries and B.I.F., Ltd.

Anything your journal can do to give the Electrical Section a " boost " will I am sure be very much appreciated by those firms who are exhibiting in the Electrical Section at Olympia.

*Birmingham, 10.* W. PERCY MCGEOCH,
*Chairman,*
B.I.F. Electrical Exhibitors' Committee.

## *Russian Visitors Entertained*

ON 4th April, towards the end of their visit to this country, Mr. G. M. Malenkov, deputy chairman of the Council of Ministers and Minister of Power Stations, U.S.S.R., and members of his party of electrical engineers, were entertained by the London Electricity Board at a luncheon at the Savoy Hotel. Mr. H. J. Randall, chairman of the Board, presided and the company included the Lord Mayor (Alderman Cuthbert Ackroyd), the Russian Ambassador (Mr. Jacob Malik), Mr. Hugh Gaitskell (Leader of H.M. Opposition), Lord Chandos (chairman, A.E.I., and president, B.E.A.M.A.) and Lord Citrine (chairman, C.E.A.).

The Lord Mayor extended a welcome to the delegates and then Mr. Randall proposed the health of the delegation. He spoke of the links between Moscow and London over the past 400 years, beginning with some British merchants, under Sir Richard Chancellor, who visited Moscow in the time of Ivan IV. Mr. Randall mentioned that Ivan had sent a proposal of marriage to Queen Elizabeth I and he speculated on the possible results upon European history if the offer had been accepted. He also referred to the four nephews of Boris Godonov who had come to this country, one of them taking orders in the Church of England, and to Peter the Great who had worked at a Deptford shipyard.

Mr. Malenkov expressed his appreciation of the cordial reception which he and his party had been given and said that they had seen many things which they could apply in their own power systems. He hoped that they would, in return, be able to show a British delegation some Russian developments which would be useful to them.

A farewell dinner was given by the Central Electricity Authority at Grosvenor House, Park Lane, on 5th April, the toast " Bon Voyage " being proposed by Lord Citrine, chairman of the Authority, who paid a tribute to the keen interest and insight which Mr. Malenkov had displayed during the visit and also to the high technical competence of the members of the delegation.

Mr. David Renton, Parliamentary Secretary, Ministry of Fuel and Power, seconding the toast, said he hoped Mr. Malenkov would carry back to his colleagues in the Soviet Union the impression that the British people were friendly, peace-loving and progressive.

Mr. F. Foulkes, president of the Electrical Trades Union and chairman of the employees' national committee, supported the toast on behalf of trade unionists.

Mr. Malenkov thanked the Government, the C.E.A. and all who had helped to make the visit a success and proposed a toast, drunk by all the Russians present, including Mr. Malik, the Soviet Ambassador, to " the strong and inviolable friendship between our peoples."

Earlier, at a Press conference at the Soviet Embassy, Mr. Malenkov expressed appreciation of the warm and friendly welcome accorded them wherever they went and thanked Lord Citrine for the fine reception and excellent organisation of the visit. " In our opinion the establishment of personal contact with the British electrical industry is a great step toward developing co-operation in the exchange of technical experience between our countries," he said.

## *E.D.A. Annual Conference*

THE annual conference organised by the British Electrical Development Association has been held this week at the Caxton Hall, London, S.W.1. It began on Tuesday with Mr. D. Bellamy, O.B.E. (chairman, Yorkshire Electricity Board), presiding, when Mr. J. Eccles, C.B.E. (deputy chairman (operation), C.E.A.) gave the opening address on " Generation Developments—Plans and Prospects."

He said they had now reached the point in power station planning in which plant could be ordered as little as 3½ years before the commissioning date. By 1964 about 36,000 MW of installed plant would be needed and this would mean installing 1,900 MW annually, against 1,700 MW at present. They were pleased with developments on 120 MW sets and had recently cancelled twenty-six 60 MW sets and replaced them with orders for thirteen 120 MW sets. This would save £7,000,000 in capital costs and £1,000,000 annually in fuel costs. The new 200 MW sets were hoped to have efficiencies of 35·6 per cent and by 1962 70 per cent of the new plant to be commissioned would be in sizes of 200 MW or above. Mr. Eccles also discussed the future nuclear plant programme.

At the afternoon session Mr. J. Gogan (chief commercial officer, South of Scotland Electricity Board) presented a paper on " Better Lighting of Commercial and Industrial Buildings by Illuminated Ceilings."

On Wednesday morning Mr. W. G. H. Chilvers (assistant chief commercial officer, North Western Electricity Board) spoke on " Organising to Meet Competition." A paper by Mr. Philip Honey (E.D.A.) on " The Place of Electricity in a Smokeless Age " was given in the afternoon. Yesterday (Thursday) morning Mr. Ellis E. Somake (staff architect, Dolcis Shoe Co.), Mr. A. H. Olson (managing director, Courtney Pope (Electrical), Ltd.) and Mr. K. C. White (manager, display lighting division, Courtney Pope (Electrical), Ltd.) presented their paper " Planning the Service Centre," whilst " Automation " was the subject of a paper by Mr. L. Landon Goodman (E.D.A.) in the afternoon.

The conference ends to-day (Friday) at the Connaught Rooms, Kingsway, W.C.2, with a general discussion at 10 a.m. and a luncheon at 1.15 p.m. under the chairmanship of Mr. D. Bellamy. A fuller report of the conference will appear in our next issue.

# SUPERVISING ELECTRICAL ENGINEERS

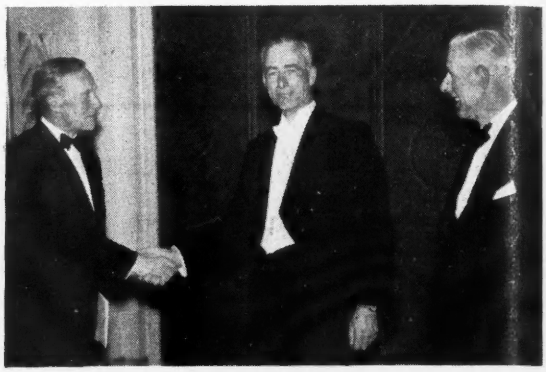
THE annual dinner of the Association of Supervising Electrical Engineers was held on 6th April, with Mr. Bryan Donkin, the president, in the chair.

Proposing the toast of "The Electrical Industry," the Earl of Verulam mentioned early historical references to electricity as power, the first he had found being Sir Thomas Browne's statement in 1646 that electricity attracted straws. That was about a century before Franklin's experiments with kites and ninety years before the birth of Galvani. Now electricity, as put to use by members of the A.S.E.E. and others, was responsible for the right development of new processes and products of profound importance to Britain at home and overseas. Lord Verulam ended his speech by reciting five amusing and topical "stanzas" (authorship undisclosed) which related to his general subject and divided the requirements under the five heads of design, manufacture, production, distribution and C.D.G.

The significance of the final, only possibly cryptic, initials was clarified in the response to the toast, which was made by Sir Claude D. Gibb. Engineers as a whole, he said, were poor publicists and were often subjected to sniping due to ignorance. There was nothing wrong with the electrical industry, upon which Britain must depend more than any other for its restoration to its former position as the greatest nation. Living standards in different countries varied in proportion to the amount of electricity used per head of population and they could not be raised here without a continuously increasing consumption. As an example of new developments, Sir Claude cited an advance of 16 per cent in Ontario last year over the previous one, which he had been informed was partly due to feeding-bottle sterilisation as an off-peak load.

While coal production, he said, was going down and oil from the Middle East could be regarded only as a temporary expedient, uranium was on the horizon. In view of the need for fuel in Britain he was convinced that the Atomic Energy Authority and the Central Electricity Authority were absolutely right in choosing gas-cooled graphite-moderated reactors for the full-scale stations now planned. Economically, they would compare with modern steam raising plant and in operation would not necessitate the learning of new methods. Moreover, they were inherently safe, which experimental types in the United States were not.

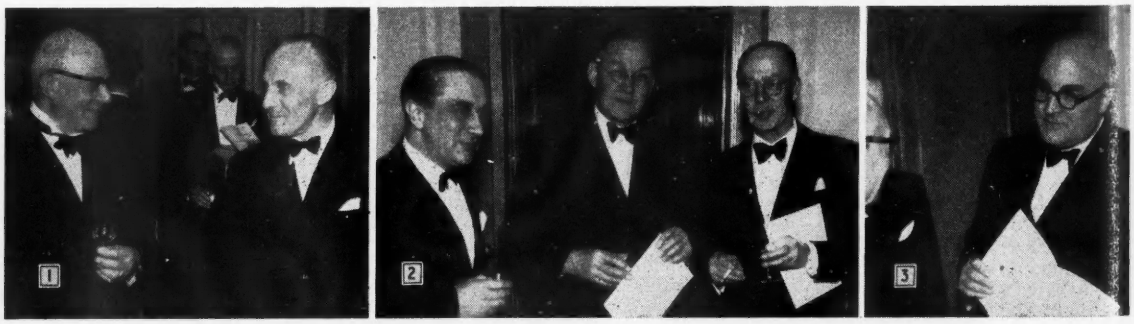
Seconding the response, Mr. R. F. Mathieson (national chairman, A.S.E.E.) pointed out that the Association represented two interdependent sections of the industry, each with a part to play in the expansion of the electrical industry which was essential to achieving the national aim of doubling present living standards. The speaker paid especial attention to the very considerable problem of inducing the right kind of boy in the right quantity to enter the industry and to qualify by extra study for more responsible positions. Provision must also be made for many skilled men, already employed, to qualify as supervising engineers; for these the practical type of education provided by the Association in the form of lectures and discussions could be of great value.



*Mr. E. R. Wilkinson being received by the president (Mr. Bryan Donkin) and the national chairman (Mr. R. F. Mathieson)*

To achieve these ends would necessitate economic prospects as good as those offered by other professions with adequate "differentials" for acceptance of superior responsibility. Members of the Association, being in close contact with employers and employees, realised that the future prosperity of the industry and the country depended upon all pulling on the same rope and in the same direction.

The toast of "Our Guests" was proposed by the president, who drew attention to the presence of leading representatives of other technical bodies and consultants, Government departments and the Services. Responding, Sir Harold Roxbee Cox took as his main theme the training of engineers. He regarded the White Paper on technical colleges as a good first step but not enough to meet the urgent needs. Russia had three times the number of entrants of professional standard yearly as this country had, aggregating twelve times the number on a basis of population. On the British side were a high "inventive quotion (I.Q.)" and ability for basic thinking with people to translate it into practice. Stressing the importance of quality as well as quantity, he pointed to the primary requisite of a broad liberal education in the schools and universities that was unconnected with specialised subjects.



**1.** *Dr. A. P. Thurston and Sir Claude Gibb.* **2.** *Sir Harold Roxbee Cox, Sir John Hacking and Mr. A. G. Ramsey.* **3.** *The Earl of Verulam*

# INDUSTRY AND THE HOUSE

## *Questions on Government Policy*

By A. M. F. PALMER, A.M.I.E.E., M.P.

A BY-PRODUCT of Mr. Gaitskell's leadership of the Labour Opposition is the more intensive questioning of Ministers on points of practical policy, especially in the field of industry, trade and economics. I am not suggesting there is anything organised about this development; it is rather that younger and more virile leadership from the front bench has stimulated the ranks behind. This is all to the good; nothing makes more for the effectiveness of the parliamentary system than a lively fear on the part of Her Majesty's Ministers that they will be called to account before the House should they be found wanting.

The still new Minister of Fuel and Power, Mr. Aubrey Jones, has not escaped attention. He has been questioned closely about the reductions in the capital investment programme of the fuel and power industries, where he gives the impression of being just a little on the defensive. He told the writer that the "regrettable" cuts would have "practically no effect" on the fuel gap in future years and went on to argue that the real trouble was "the inadequacy of savings." This seems a little hard on the electricity supply industry, which does not have any real difficulty in persuading people to invest their capital in its future. Earlier, in answer to Mr. Callaghan, Mr. Jones had said that the proposed investment programme for electricity for the coming year amounted to £204 million, of which he had approved £195 million. The reduction would fall in the main on generation.

### "Close Partnership" in Atomic Development

Another matter affecting electricity supply on which there is likely to be a great deal of future curiosity by Members is the relationship between the State and private industry in nuclear energy development. Mr. R. A. Butler, who as Lord Privy Seal takes questions on the affairs of the Atomic Energy Authority, in a written answer to Mr. Warby has defined the relationship as one of "close partnership." It was the Government's hope, he said, that both private and public industry would enter as extensively as possible into the nuclear field to develop commercially the civil applications of these discoveries. Nuclear power stations built for the C.E.A. would be designed and constructed by private industry; private industry and not the A.T.A. would be responsible for exports. The Authority was willing, of course, to give industry all the help which its technical resources would permit, subject to safeguards. There would be what he called "access agreements" between the Authority and private firms, although the Lord Privy Seal did not reveal the financial terms of the agreements. A point not covered is how far is there a fair field and no favour. What opportunities are there for new and untried firms to play their part in Britain's nuclear revolution? I suspect that Mr. Butler will need very soon to have an answer here as well.

The questioning to which I have referred took place, of course, before we rose for a short Easter recess. It is normal for the House when it resumes to take as its first business on the Tuesday the Chancellor of the Exchequer's Budget. This year, however, the timetable has worked out differently and Mr. Macmillan's glad or doleful tale is to be unfolded a week later. Instead the House will complete the final stages of the Clean Air Bill which has had a comparatively quiet passage in Standing Committee. The general approach of this measure is, I think, sound enough. Local authorities are to have their routine penal powers strengthened, but where technical processes of a more complex nature are involved which cause atmospheric pollution, then the Bill assumes that scientific knowledge, industrial management and the local community all have a joint interest in bringing about an improvement. Mr. Nabarro, who so often brings on his head justified criticism for his obscurantist attitude to electrical matters, deserves praise for the zeal with which he has pursued the cause of clean air in spite of the polite boredom of some of his Ministers.

### Industrial Manpower

On the formal motion for the second reading of the Consolidated Fund Bill, Mr. George Brown, Labour Member for Belper, and a former junior Minister of Agriculture, initiated a debate on the employment situation. He said that the Opposition wished for information as well as to offer a warning and make constructive suggestions for avoiding what might in the end become a serious situation. They could not accept the assumption made all too readily that it was not possible to get a man into another job unless they first put him out of work.

The Government must decide whether they were seeking to reduce financial pressure on the economy or to re-deploy industrial manpower. If the latter was desired then the Government must be prepared to take positive action, to decide what the industrial priorities were and where they wanted people to move. Many of the important jobs which needed to be done did not attract because of low salaries and wages. It required consultations between the Government and both sides of industry and not the deliberate putting of men out of work to force a change.

As principal speaker for the Government, Mr. Iain Macleod, former Minister of Health and now in charge of Labour and National Service, said it was easy for the Opposition to talk glibly about the possibility of mobility of labour without unemployment, but when they talked about numbers what they really meant were men and women. Just because there were a number of holes somewhere this did not mean necessarily that the pegs would fit into them. Many things worked against mobility of labour—occupational pension schemes, for instance. The Phillips Committee had estimated that a million workers had pension rights already and seven million more were in the process of acquiring them. Many of these schemes made no attractive provision for employees who left the firm before retirement. Mr. Macleod emphasised a point of principle. In the Government's view the level of employment and the nature of the employment offered was a matter for industry itself. He argued that the Labour Opposition's policy if applied would lead to a form of detailed central control in which they—the Conservatives—did not believe.

An excellent debate followed, with Members from both sides bringing forward their constituency problems but the impression left with me was that of a curtain-raiser before the all-important Budget drama yet to come.

# VIEWS on the NEWS

*By REFLECTOR*

DURING his tour of inspection Mr. Malenkov, the Soviet Minister of Electric Power Stations, expressed disapproval of our method of relieving an overloaded electricity supply system by reducing the frequency. He said that he preferred the direct cut by which a few of the consumers were affected and not all of them. In Russian power stations the engineers received a bonus for maintaining frequency and if it fell the bonus "disappeared." Forgoing an obvious comment, I wonder what the general effect of the Russians' visit has been. It is difficult to disentangle the technical from the political but most of the party were engineers who seemed anxious to learn from us if possible. Most people with whom I have discussed the visit consider that at least no harm has been done and it has certainly paved the way for the reciprocal tour of British electrical engineers. I think, though, that they are unlikely to get so good a "press" as the Russians have had.

* * *

In a note on small thermo-generators in the *Electrical Review* of 23rd March I quoted a statement from the *Manchester Guardian* to the effect that "in the search for new markets, there is a moral to be drawn from these two developments, which are separated by more than fifty years." I confessed that I was too obtuse to see where the moral was. Referring to this, but still not enlightening me, Mr. R. A. Watson, of Tadley, Basingstoke, says:—

> "Reactors generate almost uncontrollable quantities of heat, and this is usually converted into electrical energy by first changing water from liquid to gas, then absorbing the energy of the gas in a machine which in its turn drives another machine whose output is in the form of electrical energy. Would not thermo-electric generation eliminate intermediate changes in the form of energy and produce that which is required in great quantity directly from that which is available in great quantity?"

I agree: but we must at the moment make the best of what we have. Work on the direct derivation of electricity from reactor heat is proceeding but we cannot wait for its fruition.

* * *

In this inflationary period it is commonly found that the blame for higher costs is always attributed to someone else. Employees calling for more wages point to their employers' excessive profits, while the employers justify their prices by referring to ever-mounting labour costs. The same thing goes on between industries. In *The Times* recently a shipbuilder complained of the high cost of electricity; he said that the price per unit in his Glasgow shipyard had risen by more than 150 per cent since 1944 and almost implied that the rise in the cost of ships was entirely due to this. Somebody else hastened to point out that although electricity had become dearer since 1944 its price had been pegged for about five years. This correspondent alleged that "shipowner after shipowner" had complained of the fourfold rise in the cost of new ships. The first writer's rejoinder was that ships are now much more elaborate than the "austerity" wartime built vessels and had altered substantially in character while the unit of electricity had not. A great deal of the C.E.A.'s coal supplies are seaborne; I wonder how much the cost of colliers has risen.

* * *

Every year possible delegates to the British Electrical Power Convention eagerly await the announcement of the place and date of the following year's gathering and when they get information hasten to book hotel accommodation, which is always at a premium. This year the matter has been settled rather earlier than is customary. For the benefit of those who have not already heard I may say that I am credibly (but unofficially) informed that the 1957 Convention will be held at Eastbourne during the week commencing 17th June.

* * *

The Mayor of Newcastle-under-Lyme seems to have got into hot water for having told a local women's organisation that the day was coming when electricity, and then atomic energy, would supersede gas. A report has reached me to the effect that Alderman G. L. Barber at a recent meeting of the West Midland Gas Consultative Council took exception to the remark, which, he said, had made some gas industry employees consider transferring to electricity to be sure of their jobs. Although the immediate outlook for the gas industry does not, perhaps, justify such drastic steps, the remark at the same meeting by Mr. J. Lewis, the Council's chairman, that the gas industry would be maintained for a long time to come, does seem to imply some misgiving as to its ultimate fate.

* * *

Current discussions on the relation of the arts and the sciences had their counterpart eighty years ago. At a meeting of the Victoria Philosophical Institute, reported in the *Electrical Review* of 15th April, 1876, a paper "On the Place of Science in Education" was read by Professor H. Alleyne Nicholson.

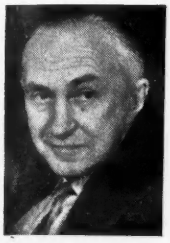
> "The author reviewed generally the place which science ought to occupy in a rational scheme of education. The claims of science as an educational agent were considered as regards its disciplinary value, its utility, and its capacity of ministering to a higher culture. The relations between science on the one hand and religion and philosophy on the other hand, were also discussed at some length, and it was pointed out that science would not occupy its true position in education till it was admitted to have a secondary interest in causes and ends, in addition to its primary concern with phenomena. The author concluded by urging the importance in the investigation of truths, of whatever order, of maintaining an affirmative rather than a negative mood of mind, the true function of science being constructive rather than destructive."

# PERSONAL AND SOCIAL

## *News of Men and Women of the Industry*

Owing to his absence abroad **Lord Citrine** will be unable to be present at the annual luncheon of the Electrical Research Association on 2nd May, and **Lord Chandos** has agreed to remain in office for a short period and will preside.

**Mr. W. J. Sommerville,** London manager of the Fraser & Chalmers Engineering Works of the General Electric Co., Ltd., retired on 31st March after thirty-six years with the company.



*Mr. W. J. Sommerville*

Mr. Sommerville was born in Glasgow and was educated in Edinburgh. At Edinburgh University and at the Heriot-Watt College he obtained special certificates for metallurgical, mining and mechanical engineering. His early working life was spent in British Columbia and on the Gold Coast. He returned to the United Kingdom at the outbreak of war in 1914 and joined the 3rd Lowland Brigade of the Royal Field Artillery. He subsequently returned to West Africa and later came back to the United Kingdom, where he joined the staff of Fraser & Chalmers Engineering Works at Erith in 1920. For ten years he represented Fraser & Chalmers' interests in India at the company's Calcutta office. In 1930 he took up the position of London manager. Between 1939 and 1945, in addition to his responsibilities in London, he also managed the Mining and General Engineering Department at Erith. Mr. Sommerville intends to return to Scotland.

**Sir George Nelson,** Bt., chairman and managing director of the English Electric Co., Ltd., is to have the honorary freedom of Stafford conferred on him at a ceremony to take place on 7th May at the Guildhall, Stafford.

**Mr. L. F. Jeffrey,** controller of the East Midlands Division of the Central Electricity Authority, has accepted the invitation of the Marquess of Salisbury, the Lord President of the Council, to serve on the Court of Governors of the University of Nottingham. He has also been appointed a member of the Engineering Advisory Committee of Nottingham University.

Associated Electrical Industries, Ltd., announce that **Mr. R. Craig Wood** has been appointed managing director of the Hotpoint Electric Appliance Co., Ltd., a member of the A.E.I. group of companies, and has relinquished his position as an executive director of Beecham Group, Ltd.

**Mr. W. H. Foster,** A.M.I.E.E., M.Inst.F., has been appointed generation engineer (operation)—Group I—of the London Division of the Central Electricity Authority. Mr. Foster served an apprenticeship at Barnsley Main Colliery, where he was electrical engineer until 1943. After service at Ferrybridge he went to Fulham and was later appointed assistant superintendent at Brighton "A" station, becoming superintendent of Brighton "A" and "B" in 1952.

**Sir Ben Lockspeiser,** who recently retired from the Department of Scientific and Industrial Research, has joined the board of Tube Investments, Ltd., and has been appointed scientific adviser to the Tube Investments group. He has also accepted an invitation from Ferranti, Ltd., to act as consultant.

**Mr. E. H. P. Lucas** has been appointed a director of Ward & Goldstone, Ltd. **Mr. F. W. Clark** has resigned from the board.

The Minister of Fuel and Power has reappointed **Mr. J. R. Potts,** O.B.E., J.P., of Carlisle, and **Mr. E. J. Smith,** of Heapey, Chorley, Lancs, as part-time members of the North Western Electricity Board.

**Mr. John A. Howie,** B.Sc., M.I.W.M., has been appointed to the board of the Lightfoot Refrigeration Co., Ltd., and has become deputy managing director. In 1946 he was appointed works manager of the E. K. Cole, Ltd., factory at Rutherglen, Lanarkshire. Three years later he went to India as resident director and general manager of the National-Ekco Radio and Engineering Co. Returning to England in 1951, he became general works manager of Enfield Cables, Ltd., an appointment he held until joining the Lightfoot Refrigeration Co. last November.

*Mr. J. A. Howie*

**Mr. H. J. Taylor** has been appointed manager of the Hadyn Park Works, Shepherd's Bush, London, of Johnson, Matthey & Co., Ltd., in succession to **Mr. A. Godden.** Mr. Taylor joined Johnson, Matthey & Co. at the Hadyn Park Works in 1935 and in 1945 took charge of the rolling mills. He was promoted to assistant manager of the Hadyn Park Works in 1953. Mr. Taylor's appointment will enable Mr. Godden to concentrate on his responsibilities as the company's general production manager.

**Mr. Kenneth R. Albrow,** for many years with the Carbon Brush Department of the Morgan Crucible Co., Ltd., has now taken up an appointment in the Sales Department of Nobrac Carbon, Ltd., Commerce Way, Lancing, Sussex.

A new division for the design and production of electronic control units for automation in industry, in conjunction with an automation advisory service to manufacturers, has been formed by Bonochord, Ltd., and two new senior technical appointments have been made. **Mr. R. A. Cail** has joined the company as chief engineer, and **Dr. Frank Roberts,** M.Sc., has been appointed senior development engineer. Mr. Cail was formerly with E.M.I. (Engineering Developments), Ltd., and Dr. Roberts was with the Bendix Aviation Corporation in the United States, and also at London University.

*Mr. R. A. Cail*

It was announced at the annual general meeting of the Expanded Metal Co., Ltd., on 5th April, that **Sir Patrick Hamilton,** Bt., had been appointed chairman of the company. He succeeds his cousin, **Lieut.-Commander G. C. Hans Hamilton,** C.B.E., who has been chairman since 1947, and who remains a member of the board. Sir Patrick, who was appointed vice-chairman last year, is a director of a number of industrial companies including Simon-Carves, Ltd., Renold Chains, Ltd., Dudley Foundry Co., Ltd., Thos. Adshead & Co., Ltd., and Henry Simon Holdings, Ltd.

**Mr. Philip Carnell** has been appointed home sales manager of the Kenwood Manufacturing Co., Ltd., Woking. Mr. Carnell joined the Kenwood sales staff in May, 1955, and was previously Far Eastern representative in Shanghai for Arthur Balfour & Co., Ltd., Sheffield.

**Mr. G. Boggon,** a leading advertising expert, who in addition to serving on other committees for charitable

appeals, was vice-chairman of appeals on Sir Christopher Chancellor's Sub-Committee for the King George VI Memorial Fund, has been appointed president of appeal for 1956 of the Royal Commercial Travellers' Schools, of which he is an old boy.

**Mr. F. Seddon,** M.I.E.E., has been appointed sub-area engineer in the No. 3 (Sheffield) Sub-Area of the Yorkshire Electricity Board in succession to **Mr. W. E. B. Nettleton,** M.I.E.E., who recently became sub-area manager at Wakefield. Mr. Seddon was educated at the Wigan Mining and Technical College and after training at Metropolitan-Vickers, became chief test engineer to the Shropshire, Worcestershire & Staffordshire Electric Power Co. He was subsequently on the staff of the Walsall Electricity Department and in 1940 joined the Sheffield Electricity Department. Following the nationalisation of the industry he was, in 1949, appointed deputy engineer of the No. 3 (Sheffield) Sub-Area, Y.E.B.

He is a past-chairman of the Sheffield Sub-Centre of the Institution of Electrical Engineers and is now hon. treasurer. In 1949 he was president of the Electrical Power Engineers' Association.

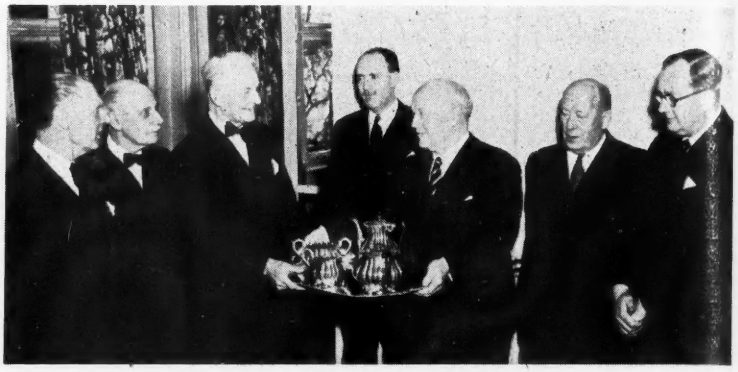
**Mr. J. Beresford,** who has been assistant head electrician, head electrician and latterly unit electrical engineer at Langwith Colliery, Derbyshire, has been appointed group electrical engineer to No. 4 Group, No. 1 Area, National Coal Board.

**Mr. A. J. Betts,** A.M.I.E.E., has been appointed London district office manager by the Edison Swan Electric Co., Ltd. Starting his career as an engineering apprentice with the English Electric Co. in 1932, Mr. Betts was later appointed sales engineer with the same company. In 1937 he joined Johnson & Phillips, Ltd., as sales engineer, and remained with them until 1947. In that year he joined Enfield Cables, Ltd., as area manager, rising to home sales manager and was general sales manager from 1954 to 1956.

*Mr. A. J. Betts*

**Mr. F. E. V. Spencer,** A.M.I.E.E. (works manager) and **Mr. O. Turner** (chief chemist) have been appointed executive directors of Lodge Plugs, Ltd. Mr. Spencer, who now becomes works director, joined Lodge Plugs in 1954 and was previously with the General Electric Co., Ltd.

The Baird & Tatlock group of companies announce that **Sir Bernard Keen,** D.Sc., F.Inst.P., F.R.S., and **Mr. A. G. P. Powell,** B.A.(Oxon), have been elected to the board of Baird & Tatlock (London), Ltd., and **Mr. W. C. Johnson,** M.B.E., F.R.I.C., and **Mr. H. N. Ricketts,** B.Sc., F.R.I.C., have been elected to the board of Hopkin & Williams, Ltd.



*The presentation to Mr. T. H. Windibank showing (left to right) Mr. C. F. Dickson, Sir Charles Bruce-Gardner, Bt. (vice-chairman), Mr. Windibank, Mr. J. V. Daniel (joint managing director), Mr. Albert Parkinson (chairman), Mr. E. C. Holroyde (vice-chairman) and Mr. Arthur Parkinson*

**Mr. and Mrs. V. W. Dale,** who are convalescing on the south coast after their recent illnesses, thank their numerous friends in the industry for their many kind inquiries and letters, etc. They hope to acknowledge them all personally in due course. Mr. Dale expects to be able to resume his normal activities shortly.

**Miss E. D. Lockley,** chief demonstrator of the Midlands Electricity Board, is retiring on 30th June after thirty-nine years' service in the electrical industry. She was one of the pioneers in her specialist field and is believed to be Britain's longest-serving electricity demonstrator. Her career began in 1917 when she became the first demonstrator on the showroom staff of Wolverhampton Corporation Electricity Supply Department. In 1925, following a short period with a firm of electrical equipment manufacturers, Miss Lockley was invited to become the first demonstrator on the staff of the former Shropshire, Worcestershire & Staffordshire Electric Power Co., with headquarters at Mucklow Hill. After nationalisation she remained at Mucklow Hill as chief demonstrator of the M.E.B. and has been leader of a staff of ninety demonstrators, with responsibility for the domestic science side of the Board's training programme and for tests of domestic equipment carried out at the Board's appliance testing centre at Springsmire, near Dudley. Miss Lockley was a founder member of the Birmingham Branch of the Electrical Association for Women, and one of the first winners of the Association electrical housecraft diplomas.

**Mr. T. H. Windibank,** C.B.E., M.I.E.E., whose retirement from the board of Crompton Parkinson, Ltd., we have already reported, was recently presented with a George IV silver tea set by Mr. Albert Parkinson, M.B.E., chairman of the company, in the presence of the board of directors, in recognition of his long service.

**Mr. R. W. F. Ell,** M.A.S.E.E., senior London sales representative of William McGeoch & Co., Ltd., has been appointed London manager. The company also announces the appointments to the London area outside sales staff of **Mr. W. H. J. Andrews** (late Crypton Equipment, Ltd.) and **Mr. P. Gould** (late Siemens Electric Lamps & Supplies, Ltd., and Blanchflower Electrical Wholesale, Ltd.).

**Mr. R. Adamson,** A.S.A.A., and **Mr. W. D. Harley-Mason** have been appointed to the board of the Gabriel Manufacturing Co., Ltd., of Torquay, a subsidiary of Tecalemit, Ltd. In addition Mr. Harley-Mason becomes general manager of the Torquay subsidiary.

The annual general meeting of the Sussex Centre of the **Electrical Industries Benevolent Association** will be held on 2nd May (5.30 p.m.) at the offices of the South Eastern Electricity Board, Castle Square, Brighton, 1.

The annual golf competition of the North West (Manchester) Area Golf Sub-Committee of the **E.I.B.A. National Golf Championship** is to be held at Torkington (Stockport) Golf Club on 2nd May.

The "Ferranti" trophy will be presented to the player returning the best net score, playing either in the

**ELECTRICAL WHO'S WHO**

The 1956–57 edition of the "Electrical Who's Who" is now available from Iliffe & Sons, Ltd., Dorset House, Stamford Street, S.E.1. This edition has been considerably enlarged and contains some 7,000 entries in addition to the index in which names in the biographical section are classified under companies or other organisations. The price remains at 21s (postage 1s 5d)

morning or afternoon. The winner, together with the competitor returning the next best score, and the competitor returning the lowest scratch score are eligible to take part in the National Final to be played at Bristol on 1st October. Further particulars can be obtained from Mr. J. K. Dean, Ship Canal House, King Street, Manchester, 2.

At the annual general meeting of the **Electrical Wholesalers' Federation** Mr. G. Conradi, chairman of the E.W.F.-E.I.B.A. Committee, reported that the 1955 collection by members of the Federation for the Electrical Industries Benevolent Association had been £2,659 11s. The cup presented by Mr. W. Yuille, a former chairman, for the highest average individual contributions was awarded to the London & Eastern Section. During the meeting the collection from members present realised £150 16s.

The annual dinner of the **Admiralty Electrical Engineering Officers** was held on 20th March at Forrt's Restaurant, Bath. The toast to the Admiralty Electrical Engineering Officers was proposed by Mr. C. A. J. Martin, of Crompton Parkinson, Ltd., who said that there were many there whose names were respected in every circle of technical competence. The manufacturers admired the skill and ability with which the majority of technical problems were tackled and overcome.

Sir Hamish Maclaren, the Director of Electrical Engineering, Admiralty, in responding, said that in the field of warship design and fitting out there were the same old problems of trying to get a quart into a pint pot. The Americans in many directions had arrived at very much the same answers in methods and procedures. They had gone ahead of Great Britain, however, in the field of cable design, producing an entirely new line in ship-wiring cables to save weight and volume.

Gold watches to mark twenty-five years' service were presented to six more employees of the Willesden Works of **Lancashire Dynamo & Crypto, Ltd.,** by the joint managing director, Mr. D. C. Lorkin, during the company's tenth annual dance and cabaret held at the Porchester Hall, Bayswater, on 6th April.

The annual apprentice dinner of **South Wales Switchgear, Ltd.,** was made the occasion for a visit from Mr. F. J. Pascoe, chairman of Aberdare Cables Holdings, Ltd., and South Wales Switchgear, Ltd. Some 170 apprentices were assembled for the annual gathering, and invitations were accepted by the principals of the four major technical colleges of Cardiff, Glamorganshire, Monmouthshire and Newport. The occasion was also marked by the presentation of awards to various apprentices in the organisation.

## OBITUARY

**Mr. J. F. Wallace.**—We regret to learn of the death, on 1st April, of Mr. J. F. Wallace, who was general secretary of the Electrical Power Engineers' Association for seven years. Mr. Wallace was apprenticed in the engineering industry and he entered the service of the E.P.E.A. in 1921 as Scottish divisional secretary. He became an assistant secretary in 1929 and was appointed to succeed Mr. W. Arthur Jones as general secretary in 1946; he retired at the end of 1952.

*The late Mr. J. F. Wallace*

During his term of office he was called upon to deal with the many matters affecting electrical power engineers arising from the nationalisation of the electrical supply industry. Mr. Wallace had also acted as secretary of the industry's Employees' National Committee.

**Mr. Ben Gardner,** who had been general secretary of the Amalgamated Engineering Union since 1943, died on 6th April at the age of fifty-nine.

**Mr. E. R. Morris.**—For many years in business as an electrical engineer and contractor in Chesterfield, Mr. Edgar Reynolds Morris has died at the age of seventy-nine. He founded his business of E. R. Morris, Ltd., Irongate, Chesterfield, in 1908.

**Mr. N. C. Robertson.**—The death occurred on 1st April, at the age of forty-seven, of Mr. Norman Charles Robertson, C.M.G., M.B.E., Associate I.E.E., deputy managing director of E. K. Cole, Ltd., and a director of Ekco Electronics, Ltd. Mr. Robertson was apprenticed to the Sterling Telephone & Electric Co., Ltd., in 1924 and later joined Marconi's Wireless Telegraph Co., Ltd., as an engineer. In 1928 he became chief of test with Kolster-Brandes, Ltd. He joined E. K. Cole, Ltd., as chief of test in 1930 and within the next thirteen years he became, successively, production manager and works manager. In 1943 he was appointed to the board and two years later was elected deputy managing director.

*The late Mr. N. C. Robertson*

In 1951 Mr. Robertson accepted the then newly-created position of Director-General of Electronics Production, Ministry of Supply, and while at the Ministry he was responsible for co-ordinating the production of electronic equipment for the defence programme. He returned to E. K. Cole, Ltd., in 1953 and in the following year received the C.M.G. for his services in the Ministry. He was a fellow of the Royal Society of Arts, a Freeman of the City of London, a member of the British Institution of Radio Engineers, and of the Institution of Production Engineers, and a member of the Worshipful Company of Horners.

**Mr. John Morris Sim,** a former director of the Sloan Electrical Co., Ltd., died on 16th March at Westcliff-on-Sea at the age of seventy-nine. Mr. Sim retired in 1936.

**Mr. J. R. Cheetham,** who retired from the position of export manager of the Edison Swan Electric Co., Ltd., at the end of last year, died on 28th March at the age of seventy-three. A full account of his career was given in our issue of 30th December. Following his official retirement on 31st December last, Mr. Cheetham had continued to attend the office occasionally to facilitate the handing over of his responsibilities and on 28th March he had planned a small leave-taking party of close friends. Shortly before lunch he became ill whilst walking through Soho Square Gardens and died before the arrival of an ambulance. At a small ceremony only a week before, Mr. H. Butterworth, managing director of Edison Swan, had presented Mr. Cheetham with an "Ekco" television set from his colleagues and a small engraved plaque to be displayed in the rose garden (some 18 bush roses and a standard rose) previously given to Mr. Cheetham by his staff of the Export Department.

*The late Mr. J. R. Cheetham*

**Mr. A. E. Sharman,** a director of Alliance Wholesale, Ltd., for many years, died on 3rd April.

**Sir Montague Hughman.** — A memorial service to the late Sir Montague Hughman was held on 5th April at the parish church of St. Sepulchre-without-Newgate, London, E.C.1, and was attended by a representative gathering of the electrical industry. The service was conducted by the Rector, the Rev. G. H. Salter.

## WILLS

**Sir Felix Pole,** formerly general manager of the old Great Western Railway and chairman of Associated Electrical Industries, Ltd., and a director of other companies, who died on 15th January, left £109,330 gross (£102,129 net).

**Mr. F. H. Rogers,** a director of the British Vacuum Cleaner and Engineering Co., Ltd., who died on 27th November, left £114,474 gross (£112,957 net).

# INDUSTRIAL NEWS

## Industry's Aid for Education

Last November it was announced that an Industrial Fund for the Advancement of Scientific Education in Schools had been established by a number of prominent industrial concerns (see *Electrical Review*, 4th November, p. 895). The purpose was to provide grants to independent and direct-grant schools for the erection, expansion, modernisation and equipment of science buildings at these schools.

It was then stated that £1½ million had been guaranteed by the seventeen founder members. Since that time a further 73 concerns have agreed to support the Fund and the total now received from all sources is £2,900,000. It is estimated that a further £600,000 will be needed to carry out the programme envisaged by the Committee.

Applications have been received from 439 schools and four assessors have been appointed to act as technical advisers to the Committee and the schools. So far 45 schools have been visited by an assessor; seven offers have been made by the Committee and 20 are in the course of negotiation.

It has been decided that grants will generally be restricted to the teaching of the fundamental sciences of physics and chemistry and of mathematics; grants will not exceed two-thirds of the cost of projects admissible for consideration; and preference will be given to schools having 250 or more pupils over the age of 13, of whom at least 10 per cent must be in the mathematics and science sixth forms.

## Electrical Industries Club

The second annual general meeting of the Electrical Industries Club was held at the Connaught Rooms, London, W.C.2, on Tuesday last. The General Committee of the Club reported that the attendance at the monthly luncheons during the past year averaged 120; there were about 280 present at the Christmas luncheon.

Up to the present limited accommodation has precluded acceptance of applications for membership, except on a modest scale, but from next autumn it is hoped to have more room which will permit an increase in membership. At 31st March there were 260 members. A wide variety of speakers have been the principal guests at the luncheons. A total of £246 has been collected at luncheons for the Electrical Industries Benevolent Association.

The Committee pays a tribute to the work of the president (Mr. Leslie Gamage) and the vice-president (Mr. E. G. Batt).

At the meeting the report and accounts were adopted and it was announced that the new member of the General Committee in place of Mr. V. W. Dale was Mr. L. J. Luffingham (C.E.A.). Mr. E. G. Batt, vice-president, who was in the chair, said that Mr. Leslie Gamage had agreed to continue as president for a further year. He thanked Mr. Gamage and the hon. secretary (Mr. A. S. Lowe), the hon. social secretary (Mr. H. F. Wickham) and the hon. treasurer (Mr. H. S. Fothergill) for their services to the Club. It was agreed that lady guests should be invited to the July luncheon and the decision to provide name badges for members was approved.

Mr. Gamage presided at the subsequent luncheon when Mr. Harold Abrahams, the well-known athlete, was the guest speaker. He assessed Great Britain's chances in the Melbourne Olympic Games and appealed for financial support for the British team. Mr. E. B. Sawyer proposed the vote of thanks to Mr. Abrahams.

Membership of the Club is open to any male executive or other person of responsible standing in the electrical industry or closely connected with the interests of the industry. The hon. secretary is Mr. A. S. Lowe, Kingsway House, Kingsway, London, W.C.2.

## New "Atomic" Company

Richardsons, Westgarth & Co., Ltd., announce the formation of a separate company to take over the group's studies and developments in the atomic field. This subsidiary, Richardsons, Westgarth Atomic, Ltd., has a capital of £250,000. Mr. Harry Fothergill is chairman and the other directors are Messrs. O. J. Philipson and J. R. Mackay. They are all directors of Richardsons, Westgarth & Co. The registered office of the new company is at the group's London office, 56, Victoria Street, S.W.1.

## India and the World Bank

In our last issue we published an article from our Indian Correspondent on "India's Second Five-Year Plan." It was stated in this that the Bokaro thermal station had been erected by American firms "with the aid of a substantial grant from the World Bank." It has been pointed out to us that the World Bank does not make grants to firms; it provides loans to member Governments for approved projects.

## Engineering Wages Discussion

On Wednesday last week the Engineering and Allied Employers' National Federation rejected claims put in by the engineering trade unions for sickness payments, manual workers' pension scheme, double time for all night work and overtime on normal working days, treble rates for Sunday work and increased pay for skilled maintenance men.

An offer was made by the employers to raise the night-work rate from time and a fifth to time and a third and the night-work overtime rate from time and a third to time and a half for the first two hours. The result of the discussions (which also included the subject of redundancy) was reported to the executive council of the Confederation of Shipbuilding and Engineering Unions on Thursday.

## Training of Welding Engineers

Quasi-Arc, Ltd., Bilston, Staffs, announces that its next course for welding engineers, which will last for three weeks, will commence on 11th June, and there will be a further course on 27th August. Full details and application forms for enrolment will be sent on request.

## Prices of Materials

In the accompanying table we give the basis prices of the more important materials used in the electrical industry. The figures given are the selling prices and are those quoted on Tuesday last.

| | |
|---|---|
| ALUMINIUM Ingots | ton £189 0s 0d |
| COPPER, H.C. Electro | ton £384 10s 0d |
| Fire Refined 99·70% | ton £383 0s 0d |
| Fire Refined 99·50% | ton £382 0s 0d |
| COPPER Tubes .. | lb 3s 9⅛d |
| Sheet .. .. .. | ton £465 5s 0d |
| H.C. wire and strip .. | ton £439 5s 0d |
| LEAD, English .. | ton £118 17s 6d |
| Foreign .. .. | ton £117 0s 0d |
| MERCURY .. .. | flask £86 0s 0d |
| TIN, block (English) .. | ton £765 10s 0d |
| ZINC, G.O.B. Foreign | ton £99 2s 6d |
| Electrolytic .. .. | ton — |
| BRASS TUBES (solid drawn) .. .. .. | lb 3s 0½d |
| Sheet .. .. .. | ton £363 0s 0d |
| Wire .. .. .. | lb 3s 7⅛d |
| PHOSPHOR BRONZE Wire .. .. .. | lb 5s 4½d |
| PLATINUM .. .. | oz £34 0s 0d |
| RUBBER, No. 1 R.S.S. spot .. .. .. | lb 26⅞d—27⅛d |

## G.P.O. Wage Increase

Increases in wages ranging from 9s 6d a week for unskilled workers to 14s for technicians are being paid to workers in the Post Office Engineering Department as from 1st April. The Post Office Engineering Union had claimed rises of from 10s 6d to 15s a week. It is estimated that the increases mean an extra £2½ million a year.

## Cambridge Engineers' Association

The hon. secretary of the Cambridge University Engineers' Association, Mr. A. H. Chapman, Engineering Laboratory, Trumpington Street, Cambridge, tells us that the membership is now about 2,000 and a new register of members is being printed.

The Association was formed in 1929 for the purpose of keeping former

students of the University Engineering Department in touch with one another and with the considerable amount of research in progress and other activities of the Cambridge Engineering School. The Executive Committee is endeavouring to increase the membership by getting into touch with the many graduates with whom contact has been lost. The subscription for life membership is two guineas.

The next summer reunion is to be held in Cambridge on 14th July when the annual general meeting, an afternoon "at home" and a dinner will form the programme; ladies accompanying members will be welcome at the last two functions.

## Export Credit Guarantees

Immediate improvements are being made in the terms of cover offered by the Export Credits Guarantee Department of the Board of Trade, 9, Clements Lane, London, E.C.4. The rates of premium on exports to the more stable markets (110 out of 170) are reduced by between 10 and 20 per cent. These markets took over 80 per cent of our total exports in 1955. The special limitations imposed on short-term cover are removed and the terms on which cover is given for goods held in stock overseas are improved.

The Department points out that although greater cover is now provided than before the war the premiums are smaller. At the beginning of the past financial year the Department had a deficit on its "commercial" business of £610,976 but the year ended with a surplus of about £3 million.

## Trolley-buses for Johannesburg

The Sunbeam Trolley-bus Co. has recently received an order from the Johannesburg Municipality for forty trolley-buses, which are to be fitted with electrical equipment made by the British Thomson-Houston Co., Ltd. The vehicles will be of the 3-axle type, of exceptional size, each capable of carrying 105 passengers, the total laden weight being nearly 18 tons. Each vehicle will be equipped with a single B.T.H. motor having a one-hour rating of 160 h.p. at 550 V. The Johannesburg Municipality is already operating twenty-five Sunbeam/B.T.H. trolley-buses which were supplied in 1945.

## Philips Newly-Designed Showroom

The newly-designed showroom and lighting demonstration centre of Philips Electrical, Ltd., recently opened at Century House, Shaftesbury Avenue, London, W.C.2, provide an attractive contemporary setting for the company's current range of lamps and lighting equipment, radio and television receivers, records and record-playing equipment and products of the electrical appliances and electro-acoustic divisions. In addition, it constitutes a permanent working illustration of the company's lighting design service and includes practical demonstrations of many interesting lighting principles and techniques. It incorporates, also, a special "Hi-Fi" demonstration room where the latest equipment may be heard under ideal acoustical conditions. The basic design was by J. D. Layton, A.R.I.B.A., and it was carried out in association with V. Rotter, M.S.I.A. Mr. Layton, who is a member of the Philips Lighting Design team, has incorporated an excellent example of modern lighting practice. Constructional and electrical work was carried out by City Display Organisation.

*A view of the entrance to the newly-designed showroom of Philips Electrical at Century House, Shaftesbury Avenue*

The main reception area is principally devoted to a display of radio receivers and radiograms. In the adjoining T.V. demonstration room, working models of the complete range can be seen. A new demonstration unit has been provided for the "Philishave" dry shaver in the section of the showroom dealing with the products of the electrical appliances division.

In the large section devoted to lighting applications facilities are available for the practical demonstration of fundamental lighting principles. A complete shop window has been built to demonstrate different effects of showroom and window lighting, with special emphasis on colour values and light quality.

The Lighting Demonstration Centre can be curtained off from the rest of the showroom for lectures, demonstrations, etc.

## Synchro-Cyclotron at the Science Museum

Among the exhibits in the public exhibition held in connection with the Geneva Conference on Atomic Energy last August was a model of the cyclotron made by N. V. Philips Gloeilampenfabrieken of Eindhoven, Holland, which was taken into use at Amsterdam University in November, 1949. By courtesy of Philips Electrical, Ltd., the model is now being shown for a few months at the Science Museum, South Kensington, London.

The Amsterdam machine is a typical synchro-cyclotron of medium power, and accelerates deuterons to a speed equivalent to 28 MeV, the average target current being 20 $\mu$A. The diameter of the final orbit is 63in and the power dissipated at the target 560 W. The instrument is used for general research and for the production of artificial radio-isotopes.

The model, which is to scale, shows much detail of the machine and its accessories, including the electromagnet, the vacuum chamber and "dee" system, the oscillator and modulator for producing the radio-frequency accelerating field, and the instrument control panels.

## Indian Steel Works Contract

An agreement has been concluded between the Government of India and the Indian Steel Works Construction Co. for the erection of an iron and steel works at Durgapur, West Bengal, with an initial output of a million tons, to be increased subsequently to two million tons. The value of the work is said to be £80 million.

The Indian Steel Works Construction Co. is a consortium of British constructional engineering concerns and electrical manufacturers; the latter are the British Thomson-Houston Co., Ltd., the English Electric Co., Ltd., the General Electric Co., Ltd., and the Metropolitan-Vickers Electrical Co., Ltd.

## Combustion Control

We have received from the Combustion Engineering Association, 6, Duke Street, St. James's, London, S.W.1, a copy of the proceedings of the conference relating to the instrumentation and control of combustion, which was held jointly with the British Industrial Measuring and Control Apparatus Manufacturers' Association on 6th and 7th July, 1955, and reported in the *Electrical Review* of 22nd July. The document contains the text of the three papers presented and of the subsequent discussions.

## Sharples Centrifuges Expansion

Sharples Centrifuges, Ltd., announces that it is building a new head office, a pilot plant and development laboratory and factory on the York Town Trading Estate, Camberley, Surrey. These facilities are intended to handle a rapidly expanding overseas market for centrifuges and the continually increasing range of machines being developed by the company. A

prominent part of the project comprises a pilot plant and laboratory for full scale development work. The company's interests in the Stroud area will continue in association with T. H. & J. Daniels, Ltd., of Lightpill Iron Works, who manufacture a large part of the Sharples range of equipment.

### Railway Electrification Agreement

Pirelli-General Cable Works, Ltd., an associated company of the General Electric Co., Ltd., and the Pirelli group, has formed a special section in its Overhead Lines Department which will be responsible for overhead traction equipment for railway electrification. The section will shortly be prepared to deal with complete electrification schemes, from the preparation of initial track layouts to the final installation of the overhead equipment. The work will include the design, manufacture and erection of supporting structures, catenaries and contact wires, fittings, section switches and insulators, and track and structure bonds. A recently completed agreement between Pirelli-General and Brown, Boveri & Co., of Mannheim, will result in the free exchange of technical information between the two companies. Brown, Boveri & Co. are among the pioneers of railway electrification, and experience gained by them in many parts of the world will be placed at the disposal of Pirelli-General engineers.

### Marconi Instruments Showroom

A permanent showroom is being opened by Marconi Instruments, Ltd., on 23rd April at Marconi House, Strand, London, W.C.2. The showroom will contain examples of the latest Marconi Instruments equipment, together with certain products of the Marconi's Wireless Telegraph companies' equipment. These will include mobile radio systems, industrial television equipment and sound reproducing equipment, the last mentioned being manufactured by the Marconi International Marine Communication Co. A special exhibition is being held during the first week of the showroom opening.

### Irish Cables New Branch

The Belfast branch of Irish Cables, Ltd., at 2a, Hartington Street, Belfast, was opened recently in the presence of a number of well-known people, including the Permanent Secretary, Ministry of Commerce, the Permanent Secretary, Ministry of Finance, Northern Ireland, Mr. A. W. Ferguson, general manager, Electricity Board for Northern Ireland, Mr. R. W. Watson, chief electrical engineer, Belfast, Mr. T. R. Richardson and Mr. W. L. Wray (Irish Cables, Ltd.).

### The Dexion Story

A private showing was given in London last week of a film entitled "The Dexion Story," produced at the offices and factories of Dexion, Ltd., by Hartley-Ward Films, Ltd. The story shows how savings in time, labour and money can be achieved when Dexion slotted angle is used by unskilled labour for making racks, benches, conveyors, trolleys and other equipment. There are scenes of assembly lines for television production, a "water-wheel" structure devised by B.B.C. technicians to provide the captions of newsreels; and a variety of other uses are seen in action. The film is available for borrowing (free of charge) from the company at 65, Maygrove Road, London, N.W.6, in 35 mm or 16 mm sizes, with commentary in English, French, Spanish or German. The running time is 24½ minutes.

*Parallelism of ancient and modern heating methods demonstrated in Mortimer Gall's showroom window*

### "Nuclear Engineering"

The first issue of a new monthly journal entitled *Nuclear Engineering* was published on Monday last by Temple Press, Ltd., with the object of presenting the latest developments in nuclear engineering and its application to industry. This journal will deal with the design and construction of all types of reactors, fuels and fuel cycles, raw materials, the utilisation and disposal of fission products, radioactive isotopes, and education and training. Attention will also be paid to the wider aspects of nuclear engineering and the economics of the subject.

### Telecommunications Agreement

The Automatic Telephone & Electric Co., Ltd., and Marconi's Wireless Telegraph Co., Ltd., have concluded an agreement for co-operation in the field of telecommunications. The resources of the two companies will be co-ordinated, as regards development, production, planning, installation and maintenance, to enable them jointly to meet the widest possible range of telecommunications requirements.

### As the Romans Did

A short time ago Mortimer Gall & Co., Ltd., the London electrical contractors, formed a company, Mortimer Gall (Heating), Ltd., to deal with space heating—particularly off-peak thermal storage. The company has arranged a display in the window of its Cannon Street showrooms showing the similarity between the Roman hypocaust under-floor method of heating and modern electric floor warming. On one side is a photograph of a typical Roman hypocaust floor and in the centre of the display there is a model illustrating the application of "Panelec" embedded floor heating.

Mr. J. Mortimer Hawkins, managing director of the company, considers that the only future for the use of electricity for heating lies in its application to commercial and industrial buildings in which the floor construction is such as to give thermal stability. With suitable off-peak tariffs and an intelligent approach there are tremendous potentialities for floor warming which should be welcomed by the electricity supply authorities as a means of substantially improving their load factor.

### Wireless and Electrical Year Book

In our review of the 1956 edition of the *Wireless and Electrical Trader* Year Book in our last week's issue, we omitted to mention that it is published by the Trader Publishing Co., Ltd., Dorset House, Stamford Street, London, S.E.1, at 12s 6d (postage 1s), with a reduction to subscribers to the *Wireless and Electrical Trader*.

### Scientific Film Association

A conference is being held by the Scientific Film Association from 16th to 18th May at Ashorne Hill, near Leamington Spa. Application forms can be obtained from the Association at 164, Shaftesbury Avenue, London, W.C.2.

### Electro-Spark Machining

"Working Metals by Electro-Sparking" published by H.M. Stationery Office, price 5s, is an abridged translation of an original Russian work prepared as a practical manual for engineers, technicians, foremen, and all those concerned with the operation of electro-spark units.

Electro-spark machining is one of the newer techniques for working metals, particularly metals and alloys of great hardness. In this technique the erosive effect of repeated electrical discharges between tool and workpiece is used instead of conventional metal-working tools to carry out the work required. The tool itself does no actual abrading but acts only as an electrode. It can be made easily and cheaply therefore from a soft metal

such as brass and no special treatment is required. The method can also be used for sharpening carbide tools with ease and safety without destroying their temper.

An advantage of the technique is that it will produce holes of square, octagonal, star-shaped or any other required section. It is even possible to produce holes which curve along their longitudinal axes—an achievement impossible with ordinary drills.

The publication covers the physical laws governing the technique, the technological requirements for using the process and the results which can be obtained. A great deal of operating experience has already been obtained in Russian factories and the translation includes an outline of workshop procedure based on operations carried out in the workshops of industrial co-operative societies.

### Trade Announcements

The Guildford branch of the **Beacon Electrical Co., Ltd.,** is now at 40 and 41, Church Road, Guildford, Surrey. The telephone (Guildford 62271) is unchanged.

**Lithgow Electronics, Ltd.,** 1, Grange Court, Sudbury Hill, Harrow, Middx., have been appointed exclusive British representatives of the Hewlett-Packard Co., California, U.S.A., makers of electronic test instruments. Arrangements have been made with Livingstone Laboratories, Ltd., Retcar Street, London, N.19, to render on behalf of Lithgow Electronics all technical service required by these instruments.

The address of the Calcutta office of the **Pritchett & Gold and E.P.S. Co., Ltd.,** is now 31, Chittaranjan Avenue, Calcutta.

The combined Manchester depot of **Aerialite, Ltd.,** and **Nettle Accessories, Ltd.,** has been moved to larger premises at 355, Deansgate, Knott Mill, Manchester, 3 (telephone: Blackfriars 2604).

**Mr. John H. Shirley,** manufacturers' sales agent, has moved to Saffron House, 23, Charterhouse Street, London, E.C.1 (telephone: Chancery 3917).

# New E.A.W. Headquarters

IN the late summer of last year the Electrical Association for Women were compelled to find new headquarters as the premises at 35, Grosvenor Place were due for demolition. The Association has now opened its new headquarters at 25, Foubert's Place, London, W.1. Situated just off Regent Street, the premises are in the heart of London's West End shopping centre and are ideally placed to attract the attention of women shoppers. Much of the property which surrounds the new headquarters has historical connections and the contrast provided by the modern showroom windows of the Association's premises attracts the immediate attention of passers-by.

The demonstration and display room, which can be seen through the showroom windows, has a demonstration platform with kitchen equipment including a cooker, refrigerator and washing machine. Other equipment necessary to the kitchen are fitted cupboards with working surfaces and a sink with a water heater mounted above. Plate glass display shelves along the window wall show small appliances to advantage, and more shelves on the wall opposite make use of recesses to house other appliances.

In the test kitchen a "timber grid" ceiling has been necessary and constructional recesses have been used to house an automatic washing machine and a large refrigerator. Along the unbroken stretches of wall there are cookers and continuous working surfaces with cupboards below and above. A hatch with roller shutter leads from the serving area of the test kitchen into the demonstration and display room.

General lighting is by warm-white fluorescent lamps in enclosed fittings of reeded glass, supplemented by spotlights for the display cases and for the demonstration platform, and by strip lights over the working areas. A large tungsten "porthole" light illuminates the turn of the stairs leading from the demonstration and display room to the lower ground floor. In the test kitchen, in addition to general and localised fluorescent lighting, a low hanging beam has been used as a laylight. The floors above accommodate the staff.

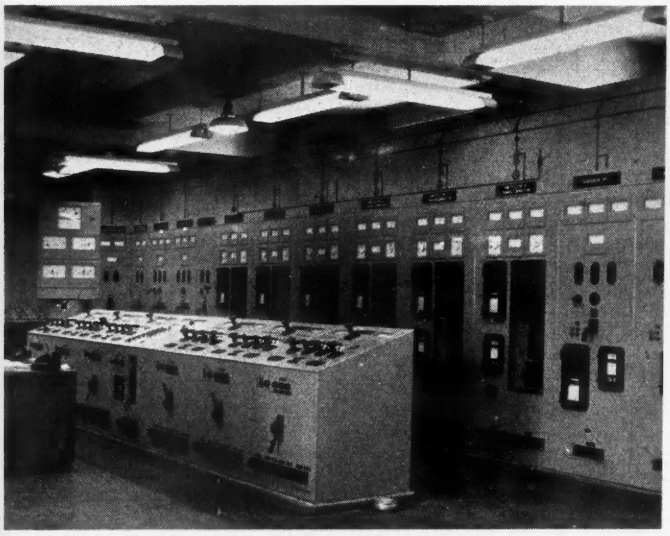
The feminine touch is much in evidence in the furnishings and colour schemes, and the whole showroom presents an inviting atmosphere to the passer-by.

At an "At Home" last week, the Dowager Lady Swaythling, president of the Association, welcomed the visitors and paid tribute to the work of Miss Vera Norvick, the assistant secretary, and the staff. Miss M. E. Bailey, head of the Housecraft Department, described some of the more important features of the new premises.

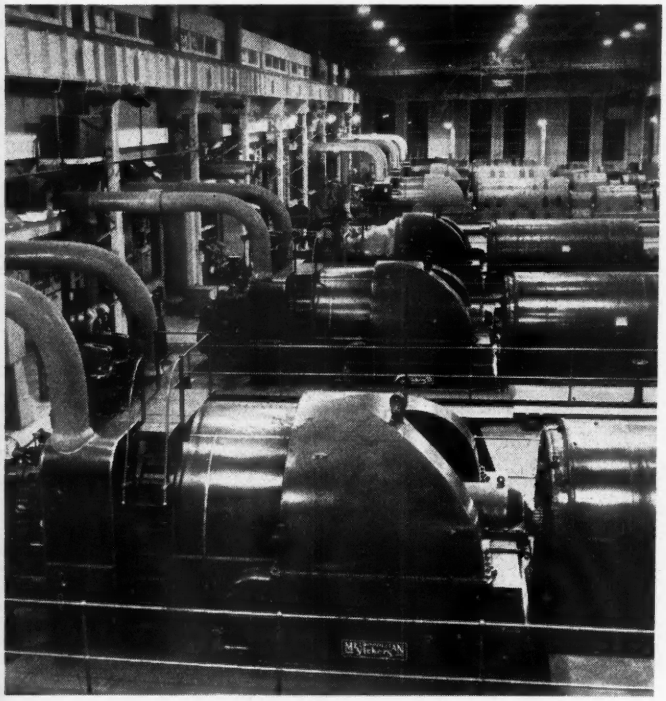
*The new headquarters of the Electrical Association for Women, showing (left) the display windows and (below) the demonstration and display room*

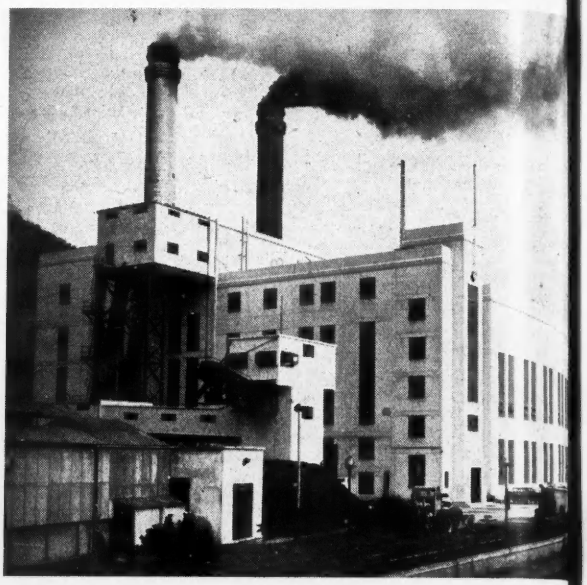
# CATALAGZI

## EXTENSIONS TO BRITISH-BUILT POWER STATION IN TURKEY



*The main control room and (below) the machine hall showing the six 20,000 kW Metropolitan-Vickers turbo-generator sets (the new sets are in the foreground)*





*Exterior of new extensions at Catalagzi power station housing three 20,000 kW Metropolitan-Vickers turbo-generator sets*

As briefly reported in our last issue, the latest extensions to Catalagzi power station, Turkey, were officially opened on 31st March by the Prime Minister, Mr. Menderes, who was accompanied by the British Ambassador, Sir James Bowker. Among others attending the ceremony was Mr. J. F. Perry, a director of the Metropolitan-Vickers Electrical Co., Ltd., and managing director of the Metropolitan-Vickers Electrical Export Co., Ltd.

Metropolitan-Vickers has been responsible, as main contractor, for the whole of the civil, mechanical and electrical work at Catalagzi (with the exception of the outgoing transmission lines). In 1953 the company received a £4 million (sterling) contract for doubling the size of the power station, and this has been completed within two and a half years. Each of the three 20,000 kW turbo-generator sets was put into operation on or before the promised date. The principal sub-contractors were Babcock & Wilcox, Ltd., for the boiler plant and auxiliary equipment and Braithwaite & Co., Engineers, Ltd., for the civil and building works.

Catalagzi power station is situated near Zonguldak in north-west Anatolia on the Black Sea and burns pulverised fuel from the local coalfields. Its electrical output is principally fed to the coal mining industry, where the use of electrical machinery is progressing rapidly, and the station also provides power for transmission to Ankara and Istanbul to supplement the generating capacity in those cities.

One result of the considerable extension of electricity supply in Turkey has been an urgent need for large numbers of operating and maintenance staff. These had to be trained in countries where equipment and experience were readily available, and under one of the schemes set up by Etibank (which controls electrical power generation and supply in Turkey) Metropolitan-Vickers became responsible for seventy-seven men, their training being shared between M-V, Babcock & Wilcox, and the Central Electricity Authority. The first group of these trainees will soon be ready to return to Turkey to take up their new work.

# Nuclear Energy Symposia

## *PROCEEDINGS OF TWO LONDON MEETINGS*

DURING the last fortnight two symposia on nuclear energy have been held in London under the auspices of the British Nuclear Energy Conference. The first of these was organised by the Institution of Mechanical Engineers on 28th March and was held at Church House, Westminster, to cater for the large number of applicants—over 1,000—for tickets to the meeting. The second was arranged by the Institution of Electrical Engineers on 6th April and held on the Institution premises.

### Nuclear Reactors

The first paper of the four at the first symposium was on "Nuclear Reactors for Power Generation" by B. L. Goodlet, until recently in charge of engineering research and development at the Atomic Energy Research Establishment, Harwell. It gave a broad and very clear introduction to the problems encountered in designing reactors for power generation and was divided into three parts dealing with the basic points of reactor technology, the application of these to actual reactor designs, and the running control of the power plant. A useful appendix to the paper as published gave a summary of the physical theory of reactors.

Many of the difficulties confronting a designer, explained Mr. Goodlet, came from the fact that power reactors must work at temperatures high enough to give reasonable thermodynamic conditions for the power plant. The problems came under four main headings: reactor physics, reactor materials, radiation and radioactivity, and engineering design. Over-riding all other considerations was the need for the chain reaction to develop, necessitating the use of materials with a low neutron absorption but with their other properties much less suitable. The geometry and dimensions were fixed by this need as reactors could not be built less than the critical size and there were no advantages in building them much over this size.

The nuclear fuel—usually uranium—set a special materials problem as in operation it suffered severe radiation damage leading to cracking and disintegration of the metallic elements; it had to be encased in impervious metallic "cans" to prevent attack by the coolant, and radioactive products entering the coolant.

Core structural materials were always of minimal thickness and the criteria were low neutron absorption per sq cm per cu cm, compatibility with the coolant, and mechanical strength at working temperature. Only five metals could be considered: aluminium, magnesium, zirconium, beryllium and niobium and the first two of these had low melting points of 660 and 650 deg C respectively.

Radioactivity and radiation had to be considered in four places: at the surface of the reactor core; in the coolant circuit and pumps; in the uranium slugs when withdrawn after service; and in possible accidents to the plant. Radiation decomposed water used as a coolant and this favoured corrosion of coolant pipework. A by-pass filter could remove corrosion product activity.

The power level at which a reactor ran was fixed only by the difficulties of heat removal and an examination of the heat transfer scheme showed how the conversion efficiency dropped considerably with increases in pumping power. Low proportionate pumping powers were hard to obtain if the coolant was a gas.

Mr. Goodlet felt that it would not pay to reduce steam pressures to get superheat, and a return to the use of saturated steam was likely for some plants, and he conveyed some idea of the complexity of design by a long list of the problems to be solved in different aspects of the plant.

The second part of the paper dealt with some detailed reactor designs particularly of a fast neutron reactor, and a rough analysis showed that only fuels of a high fissile content could be used, making for a small critical size and a small, expensive core. To keep down cost per unit of output this had to be large and the large output per unit volume led to heat removal being the limiting factor. A limit to the permissible surface heat flux meant that the cooling surface had to be large in spite of a small core; and the resulting subdivision of the core left its individual fuel elements thin and mechanically weak.

Consideration of a simple reactor made up of a tank of heavy water with some natural uranium rods suspended in it led to an appreciation of the difficulties of separating the coolant and moderating fluid, made necessary by the need to have more $D_2O$ in the core than was required for cooling, and the excessive pumping power which would be demanded if all this were circulated. Conservation of the expensive heavy water in the system became a primary concern. Boiling water reactors were also considered; in these the two major problems were to get a large steam output without a large steam content in the core to drop the moderator density, and to achieve stable operation at large steam outputs.

Part three, dealing with the running control of nuclear power plants, referred to the two functions normally allotted to a generating station. Either it supplied a definite block of load or served as a frequency controller. For the present, nuclear plants were visualised as being only on block-load duty. Dump condensers would be provided to maintain reactor power output in the event of unexpected reduction of turbine power output. It might be possible to control the power level entirely from the turbine stop valve. If steam flow were reduced, the boiler temperature and pressure would rise and raise the mean temperature of the reactor, thus reducing reactivity and the power level.

### Steam Cycles

The second paper on "Steam Cycles and Nuclear Power Plant" by R. E. Zoller, of Babcock & Wilcox, Ltd., considered the various reactor core coolant materials and discussed suitable single- and multi-pressure steam cycles for use with them. Methods of avoiding excessive moisture in the turbine exhaust, particularly applicable to water-cooled reactors, were discussed. Steam cycles were considered in relation to different types of reactor. For water-cooled reactors using light water the smallest diameter of the pressure vessel was about 10ft and a steel vessel of this size could be built for pressures of about 1,500 lb/sq in. Using heavy water the necessary pressure vessel would have to have a rather larger diameter and the coolant pressure would be limited to about 1,200 lb/sq in.

Pile coolant temperature set a limit to the maximum steam temperature. Using a light water coolant pressurised at 1,000 lb/sq in, at the turbine stop valve conditions might be 344 lb/sq in saturated and in a

modern turbine the moisture developed in the low-pressure stages produced high shock losses and caused heavy erosion. Insufficient temperature head was available from the pile for superheating. Water extraction from the l.p. stages of the turbine was possible but difficult and it was more advantageous to superheat the steam using oil fuel; by this means the stop valve temperature could be raised to 900 deg F or higher, the result being to increase the electrical output of the turbine with only a small initial expenditure. The operating efficiency of the oil heated cycle was very high and in an example quoted enabled the overall cycle efficiency to be raised from 28·5 per cent on a saturated cycle to 30·3 per cent with the addition of an oil-fired superheater.

Gas-cooled piles using carbon dioxide had greater diameters and the containing vessel limited the system pressure to about 150 lb/sq in. Various pressures could be utilised in single pressure steam cycles but although a high steam pressure raised the turbine output, the consequent higher pile inlet temperature required meant a need for more blower power and the net result could mean less power sent out. Excessive moisture was not a problem when systems operated at about 75 lb/sq in with a 230 deg F feed temperature, as was not unreasonable in this type of pile, but it was difficult to handle large quantities of steam at this low pressure. In practice a simple low-pressure cycle was not adopted; it was possible to generate 70 per cent of the steam at the inlet section of the boiler evaporator zone where there was a high temperature difference and this could result in a pressure of 330 lb/sq in and a temperature of 595 deg F. Such steam passed through a topping turbine and was expanded to 75 lb/sq in, after which it mixed with the remaining 30 per cent of the original steam output superheated to the correct temperature for mixing. Such a dual pressure cycle designed for the same coolant temperature range as a single pressure cycle resulted in a four per cent gain in turbine output.

Few gases were acceptable for pile cooling but hydrogen and helium were possibilities and both had advantages over carbon dioxide in regard to heat transfer characteristics and blower power.

Higher coolant return temperatures were possible in liquid metal cooled reactors. Piping in other parts for use with sodium and sodium-potassium alloys might be stainless steel or zirconium alloys, giving an upper operating limit of about 1,100 deg F. Since sodium and potassium became radioactive a secondary circuit had to be inserted between the pile and the boiler but the temperature loss in such an intermediate heat exchanger might be small because with liquid metal on each side of thin tubes a high heat transfer rate could be obtained.

The explosion hazard should liquid sodium reach the water could be avoided by using double tubes with mercury or lead in an annulus to conduct the heat between them.

High steam pressures were possible but would require expensive boilers and a simple steam cycle with moderate pressure and high superheat were recommended. In superheaters double tubes were not necessary as the reaction between sodium and superheated steam was not violent.

Bismuth was another possible liquid metal requiring an external circuit of chromium steel, leading to somewhat lower temperature limits, but centrifugal pumps of large output were needed.

The use of boiling water reactors meant that if it was essential to use natural uranium heavy water was required and this led to a probable stop valve pressure of 400 lb/sq in.

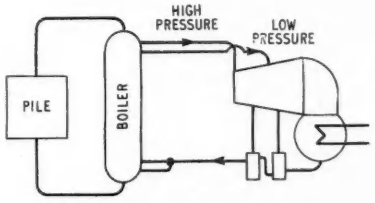
In general terms, for any reactor the whole of the steam circuit must be designed with steam speeds much less than with conventional boilers, to reduce pressure losses. A lot of work still remained to be done on the design of fuel elements; using gas cooling the present design of can should last longer if temperature cycling was not repeated more than was necessary. The pile outlet temperature could be controlled by altering the rate of gas circulation.

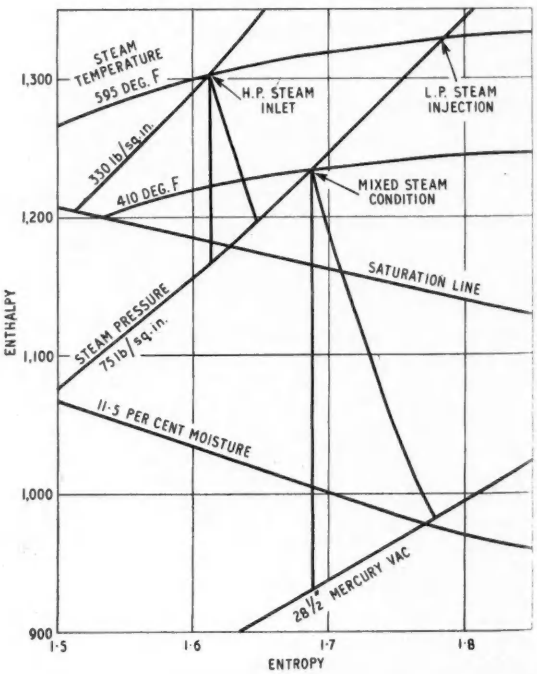
Blower drives could be electric or steam but had to be infinitely variable over a wide speed range, leading to high expense if electric motors were used. Thermal efficiency was not a good criterion for comparison with coal-fired stations. The main factor to consider was the cost of generation per kWh and this might well be reduced by sacrificing thermal efficiency for greater plant output; in the same way the case for coal-fired or oil-fired superheaters should be judged by the cost of sending out kWh. The addition of these to an atomic plant boosted the alternator output so much that it might prove economic on account of the very much lower initial cost of the superheater compared with conventional high-pressure boilers.

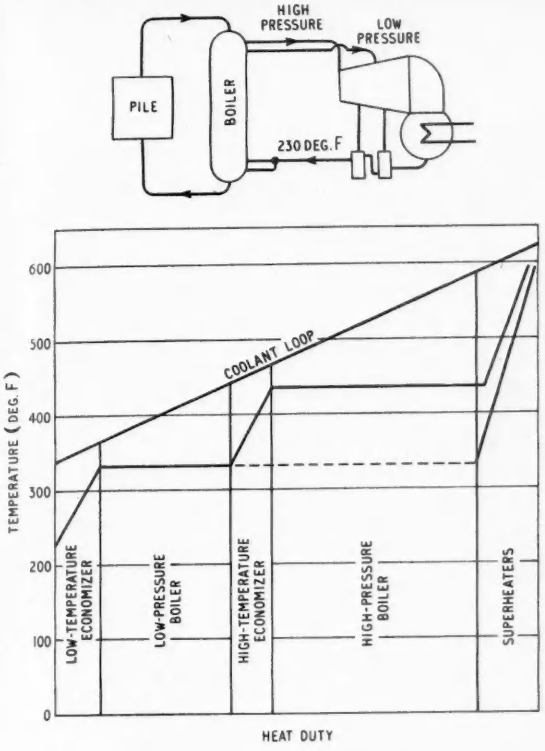
## Reactor Heat Removal

Professor Jack Diamond, of Manchester University, and W. B. Hall, of the United Kingdom Atomic Energy Authority, presented the third paper of the symposium on the subject of "Heat Removal from Nuclear Power Reactors" in which was described the general problem of heat removal from reactors where the fuel elements were in the form of solid rods or bars. Energy had to be con-

*Dual pressure cycle for a gas cooled reactor*






*Temperature diagram for a dual pressure cycle*

ducted from within the fuel to its surface and transferred from that surface by forced convection into a coolant and then transported by the coolant from the reactor; the fuel must have the highest temperature in the system.

Metallurgical considerations limited fuel temperatures and this conflicted with the desire for high coolant temperatures to achieve high heat-engine efficiencies. Theoretical considerations showed that the fuel rod centrally situated in the core released the most heat and the greatest heat release in the core would be at the middle of that rod. More economical use of the fuel was possible by the replacement of a few central fuel rods by rods of neutron absorbing material so that the average heat generation rate was brought closer to the maximum.

Considerations of neutron economy limited the materials which might be used for the fuel container to those having a low neutron-absorption cross-section. Materials such as aluminium had to be employed with consequent temperature limitations.

In determining heat transfer in the core the three main variables were the size and shape of the coolant channel; the shape and disposition of the fuel and its container in the channel; and the physical properties and mass flow of the coolant.

The coolant channel should be short from a heat transfer standpoint but a short core of large diameter had a greater neutron leakage than a core of a length equal to the diameter. An economic balance had to be sought. The heat transfer rate from the fuel could be improved by the use of thin sections with a greater ratio of surface area to volume, or by expanded surfaces. Using thin sections the critical size of the reactor was increased. Roughened surfaces on cylindrical fuel elements could also be used but this tended to increase the pressure drop and hence the pumping power.

Regarding the coolant the paper gave an approximate method for choosing between different gases on the basis of their heat transfer properties. With greater coolant mass flow more heat could be removed from the reactor and the capital cost per kW reduced; on the other hand this led to a greater running cost in the form of circulating power.

In comparing gaseous and liquid coolants, the liquid coolant required much less power for circulation and led to good heat transfer characteristics but involved an increased neutron absorption by the coolant. Liquid cooled reactors, other than those cooled by heavy water, would almost certainly depend upon a supply of enriched fuel.

In considering the liquid metals available for use as reactor coolants it seemed likely that the final choice would be between lead, bismuth and sodium or sodium-potassium alloy. The solubility of uranium in bismuth had prompted investigations into liquid metal fuel reactors.

The cooling problems of reactors were not confined to removal of heat from the fuel. The energy released in the moderator of a thermal reactor might be between 7 and 10 per cent of the total energy release and the cooling of a solid reactor shield presented another problem. Where the main shield was of concrete it was usual to form the first few inches of iron or steel plates from which the heat was removed by an auxiliary cooling system.

## Radiation Shielding

The fourth paper was delivered by Mr. C. E. Iliffe, chief technical engineer of the Industrial Group of the Atomic Energy Authority, and was entitled " Shielding Against Nuclear Radiation." This started by describing the characteristics of neutron radiation and defined the concepts of cross-section, flux and current density. The theory of neutron diffusion, used for reactor theory, as applied to the shielding problem, was discussed. The properties and sources of gamma rays were considered and it was shown that the concepts of cross-section, flux and current density were still applicable but that the diffusion treatment described for neutrons had to be replaced by one in which primary gamma rays which so far had escaped inter-action from matter were multiplied by a build-up factor to arrive at the effective radiation.

The author stated that the problem to-day was no longer one of how protection against radiation could be achieved but rather how cheaply it could be provided and in how small a bulk or with how little weight. There were three types of radiation normally encountered, namely: neutrons, gamma rays, and other particles.

Shielding requirements were controlled by two factors: behaviour of the radiation against which protection was required, and the degree of protection to be afforded. The first factor was discussed in great detail in the earlier part of the paper. Regarding the second, for health reasons the amount of radiation which the human body was permitted to receive was limited.

At sufficient distance from a compact source of neutron or gamma radiation the source approximated to a " point source " and under such conditions the inverse square law operated such that protection against these sources of radiation could be provided by physical barriers to keep personnel sufficiently far away.

When it came to shielding the core of a nuclear reactor the current of thermal neutrons was attenuated by surrounding the reactor with a material of thickness several times its diffusion length and fast neutron attenuation required the interposition of a material of several times its slowing-down length. An example quoted from the Windscale thermal reactor involved a 6in thickness of steel

followed by 8ft 6in of reinforced concrete. The steel produced a marked diffusion of the incident thermal neutrons thus protecting the concrete from excessive heating due to absorption of their associated capture gammas. On the other hand the steel was almost transparent to fast neutrons which were strongly attenuated in the concrete mainly as a result of its hydrogen content. An equally important function of the concrete was to attenuate the capture gammas generated in the steel.

The coolant circuit also involved shielding as the coolant passing through the core of a nuclear reactor became activated. Such protection could take the form of shielding by distance as in the case of the gas mains and heat exchangers and thermal reactors at Calder Hall, or of shielding by interposed material as in the case of the concrete shielding of the liquid metal circuit in the fast reactor at Dounreay.

Heat was generated in shields by the absorption or scattering of gamma photons and by the slowing down of fast neutrons and this pointed to the desirability of a high thermal conductivity in the shield material, and also to a low coefficient of thermal expansion if these temperatures were not to give rise to high stresses. With concrete some form of cooling, such as forced circulation of air, was usually demanded as the temperature of the concrete had to be kept below 200 deg C if it were not to start losing its hydrogen content which played a significant part in slowing down the fast neutrons.

In the future, research might be expected to concentrate on a better understanding of the transmission of neutrons through shields and the development of cheaper or less bulky shielding materials or combinations of materials. Concrete seemed to be very much to the fore as a suitable material. Boron emitted a very low energy capture gamma on absorption of thermal neutrons and also had an extremely high thermal absorption cross-section. It would thus appear profitable to incorporate a layer of boron-containing material immediately outside the reflector so that only fast neutrons would remain to be attenuated. This might be performed by a concrete shield which would be relieved of the heat generation due to the capture gammas emitted by a steel shield.

## DISCUSSION

The discussion on this symposium was opened by Dr. J. M. Kay, M.A., Ph.D. (Kennedy & Donkin), who said that speaking as an ordinary mechanical engineer, he had no hesitation in claiming that the large-scale industrial development of nuclear power must be carried out in the main by ordinary mechanical, civil, electrical and chemical engineers. It was therefore particularly important that the technical problems of nuclear power should be presented in an intelligible form to the engineering profession. The four papers made a valuable contribution to that process.

Mr. Goodlet had produced something that amounted almost to a text book on the theory of nuclear reactors; and Mr. Zoller had presented a most valuable survey of the various steam cycles that could be associated with a nuclear reactor. Some people nowadays seemed to think that steam was outmoded and that the more fashionable gas turbine should be the objective for nuclear power. Mr. Zoller's paper, it was hoped, would help to dispel that illusion. While the gas turbine might eventually have some part to play with small nuclear power plants, he would agree with the author that, so far as large power stations were concerned, the steam turbine was the prime mover of the nuclear age.

It had become the custom so much recently of pursuing higher and higher temperatures in combustion power plants that there was a danger of high temperature being pursued for its own sake in nuclear power plant design. It had to be remembered that a nuclear reactor was an intricate piece of structural and mechanical precision engineering. There was no similarity whatever between a nuclear reactor on the one hand and the furnace of an ordinary water tube boiler or the combustion chamber of a jet engine on the other. The important objective with a nuclear power plant was to achieve the greatest possible output without sacrifice of reliability. Nuclear power would cost anything between ½d and 5s a unit depending precisely on the reliability of the fuel elements. It was true that high temperature aided thermal efficiency, but it did not help the designer to achieve reliability or long life for his plant. The paper had shown that some perfectly good thermal cycles and acceptable thermal efficiencies might be achieved without recourse to fanciful temperatures.

Professor Diamond and Mr. Hall had reviewed the problem of heat transfer and heat removal from nuclear reactors. It was gratifying to note that they had drawn attention to the problem not merely of the heat transfer, but also of providing sufficient heat capacity in the coolant stream. The heat capacity problem would become increasingly acute with the more highly rated advanced reactors with small cores using enriched uranium, and most acute of all in the case of the fast reactor when it might be a case of dealing with a core the dimensions of which were only 2ft × 2ft.

He paid tribute to Mr. Iliffe for his very erudite paper on shielding. It would seem that the whole story had now been told for the first time.

### Dual Purpose Materials

Mr. C. J. Dalton, B.E., D.Phil. (A.E.R.E., Harwell), endorsed the view expressed by Mr. Goodlet that material would be the key to nuclear energy for some time to come. Many elements and compounds could be used as dual purpose materials. For instance, water and heavy water could be used as moderators as well as coolants, so that when those coolants were compared with others, such as sodium which could not be used as a moderator, that should be taken into account.

With regard to the question of reactivity, there were sufficient parameters available to get over almost any difficulty when it came to reactivity. There was a large area in which the ingenuity of design could overcome problems which appeared to be fundamental. In his view no good system of reactivity would suffer because of fears with regard to the stability of the reactor.

### Gas Cooling

Dr. P. Fortescue (Harwell) said that the impression might be gained from the paper on cooling that gas cooling was behind any other cooling medium. There were a number of reasons for supposing that gas cooling had a considerable future among which was that ultimately, when all-ceramic reactors became possible, it would then be essential to use gas cooling because no other medium could cope with such temperatures without corrosion troubles. Temperature would then be used to advantage to cut down the size of heat exchangers and various associated equipment.

Dr. R. J. Beale (G.E.C.) emphasised the necessity for carrying out experimental work on extended surfaces in gas-cooled reactors, any analogies with primary surfaces being quite inaccurate. The need for larger or thicker fins conflicted with the need to limit the volume of canning material in the core. It would appear, however, that the best use of the allowable material was to increase the

number of fins rather than the thickness, since the increase in the heat transferred by the larger surface area would be greater than that due to a smaller temperature drop along the fins which would result from the use of thicker fins. It must be remembered also in that connection that with a flattened pile, a larger amount of canning material in the flattened region might be employed rather than other neutron absorbing material, and higher heat transfer rates obtained thereby, although that might present problems in fuel changing and removal.

Turning to the more general picture of heat removal and to the choice of coolants, it could be clearly seen that a gas was far inferior to a liquid, either metallic or non-metallic, from the purely heat transfer aspect. There were, of course, many reasons for the use of gas-cooled reactors, including the ability to use natural uranium and their inherent safety, but many disadvantages from the purely heat removal standpoint were consequent upon its use. For future types of reactors with large outputs for a given reactor size, other coolants must be employed. Since the heart of the problem of using the heat generated by nuclear fission was to transport that heat to a place where it could be converted to other forms of energy, great prominence must surely be given to that in a reactor design, and any consequent engineering and operational problems arising from the use of the coolant must be overcome.

Mr. D. Ginns, B.A., said that the whole of the design of nuclear reactors was a compromise between the engineer and the physicist. The engineer might insist on practical thicknesses of sheaths or structural materials. The mathematics of calculating the effects from the physics point of view of the introduction of those materials was most complicated and could often be only approximate. So far as the model as presented for the physicists in the early days was concerned, they were horrified at the thicknesses demanded by the severely practical engineers for the sheaths and shell thicknesses. The engineers had to depart from any traditional ideas of safe thicknesses but had, on the other hand, to guard against reducing things like can thickness to such an extent that from a practical point of view they were running themselves into unreliable solutions.

## Shielding Techniques

Mr. D. G. Andrews, M.A. (Ministry of Defence), referred to nuclear radiation shielding and said it was a field in which the engineer had followed closely on the heels of the physicist. There were three stages in the process of placing the techniques of shielding on an engineering basis. They embodied the determination of the neutron pattern in the reactor core, the behaviour of the emergent neutrons in reflector and shield with the generation of gamma radiation, and the subsequent behaviour of gamma radiation originating from reflector and shield, from the active core itself and from irradiated materials and fission products present in the core or being handled outside.

Before the era of nuclear engineering the techniques for clinical shielding against fractional-curie gamma sources were fairly well established. The work of applying gamma shielding techniques to reactors and chemical plant therefore got away to an early start, although for a time shielding remained an art rather than a science. Difficulties had to be overcome in proceeding from fractional-curie sources to megacuries: lead, which was more or less a pure absorber at fractional MeV gamma energy, gave place to steel and to concrete. Since cost per unit mass was an important factor in mass shielding, concrete tended to become the new shielding medium.

With concrete and with distributed sources of high activity, broad beam conditions, the problem of build-up began to be important. Relatively inexact but safe methods had previously sufficed for shields of a few mean free paths, and the simplification of using energy absorption coefficients without build-up factor had considerably shortened calculated work. At shield thicknesses of more than 20 mean free paths, however, those methods proved too pessimistic, and it became more economical to use total absorption coefficients with build-up factor, at the expense of a little more calculation effort.

There were other factors in large-scale gamma shielding which became important. Not the least was the effect of capture gammas, upon which there was at first a shortage of reliable information. That situation had now been remedied.

Then again, more information was required on activation cross-sections. In many cases after prolonged irradiation relatively less abundant stable isotopes of common materials gave rise to disproportionate quantities of active isotopes, sometimes with inconveniently hard gammas.

Unsuspected activities were often encountered in irradiated material. Some showed themselves by their relatively long half lives such as fast neutron induced sodium 22 activity in sodium coolant which persisted long after the sodium 24 activity had died down. In other cases there were small proportions of high energy gammas which finally became the dominant radiations in thick shields.

In his remarks on future developments, the author rightly stressed that steel was a bad nuclear material for reactor vessels and thermal shields in view of its high capture gamma energies. Any developments towards use of materials like boron as a neutron absorber in place of steel, where structural considerations permitted, would help to reduce the size of the main shield itself through reduction of hard capture gamma emission. In the case of concrete neutron shields, the possibility of introducing hydrogen by other methods than in the cement, for example, as hydrides, should be followed up, so as to permit leaner mixes.

In the case of concrete gamma shields, the economics of heavy aggregates needed more study. Barytes might offer good possibilities on paper, but its higher expense made it a less certain starter in a large-scale programme. Steel punchings might be useful ballast in some countries, but they could less easily be spared in Britain. Iron ores might be worth following up. The aim should be to obtain material as dense and as cheap as possible, and to perform the minimum work on it.

## Civil Engineering Problems

Mr. D. R. R. Dick, B.Sc., M.I.C.E. (W. S. Atkins & Partners), said that Mr. Iliffe had stressed the urgency of pushing ahead with investigations into the mechanical properties of reinforced concrete when exposed to thermal effects. Civil engineers were well aware of the lack of experimental work in that field, and were rarely able to base their designs on known behaviour under the conditions envisaged. The difficulties experienced in the biological shields to reactors were not vastly different from those experienced in other civil engineering structures exposed to thermal effects, except for the feature of heat generated within the concrete as a result of the absorption of radiation energies.

The thermal problems which had been outlined were not in any way peculiar to atomic energy. There were, of course, additional problems arising from possible irradiation damage, and it was to be hoped that the Atomic Energy Authority would be able to include different types

of concrete (because after all, Portland cement concrete was only a generic term) in their programme of research into shielding materials.

Unless the thermal effects could be understood and related to experimental results, the civil engineer would be restricted in his ability to use the heavy biological shields in a structural sense. It was easy to visualise the day when the shields would be used as strengthening members supporting steel pressure vessels and enabling higher pressures to be achieved than were at present possible, and that merely pointed once more to the urgency of pushing ahead with investigations into the mechanical properties of reinforced concrete under thermal effects.

Mr. D. A. Howells said that precautions taken against damage to the shield by neutron and gamma heating were very elaborate, probably because designers were a bit too conscious of the upsets caused by the failure of the inner surface of a shield. The principles were not really obscure and a few experiments to confirm them would undoubtedly lead to simpler construction and a great saving.

He suggested caution in accepting the statement of Mr. Iliffe that dispensing with a thermal shield called for so much reinforcing steel as to be not worth while. Reinforcing steel which was required near the outer face of the shield was cheap and easily placed, and it was not subject to temperature or radiation effects. But a thermal shield must be supported and have expansion joints and under neutron bombardment it emitted troublesome hard gamma rays.

He drew attention to the development shown by the French G2 pile, where the pressure vessel was dispensed with and the pressure was withstood by prestressing the concrete shield. That appeared to be a promising future development.

# INSTITUTION OF ELECTRICAL ENGINEERS

AT the commencement of the meeting at the Institution of Electrical Engineers on 5th April the President, Sir George Nelson, extended a cordial welcome to the four constituent bodies associated with the Institution, and also to the delegation from the Soviet Union and representatives from Holland, Sweden, Norway, Belgium and France.

The first paper of the four presented was by Mr. A. B. Gillespie, of the Atomic Energy Research Establishment, Harwell, and dealt with the control and instrumentation of a nuclear reactor. It presented a survey of the overall instrumentation of a typical research reactor and placed emphasis on the less well-known problems of measurement and control.

Mr. Gillespie started by giving a brief account of the mode of operation of a typical reactor explaining that the fission chain reaction was controlled by altering the ratio of neutrons producing fission in the core to those suffering non-productive capture or escaping outside. It could be initiated by withdrawing neutron absorbing materials from the core, by inserting additional fuel into the core or by suitably positioning a neutron reflector outside the core to diminish the number of neutrons escaping. The control members were divided into three groups designated "safety rods," "shut-off rods" and "regulating rods." The safety rods were held right out of the core when the reactor was shut down and maintenance or fuel loading was in progress and provided a margin of extra shut-down control in the event of some unforeseen incident.

It was explained that a given position of a regulating rod did not correspond uniquely to an absolute power level and since these were used to effect fine control of reactor power they had to be driven by a servo-motor system allowing variable speed of operation in either direction.

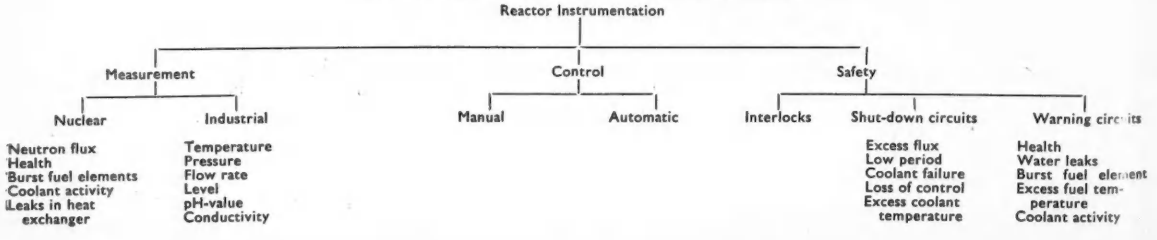
The instrumentation of a reactor could be divided into measurement, control, and safety. The most important measurement was that indicating absolute power level and the rate at which this was changing, and this involved a large operating range, rarely less than four decades. To accomplish this the neutron flux had to be measured in or near the core itself and such measurements not only provided instantaneous behaviour of the chain reaction but were also suited for the operation of level and period safety devices.

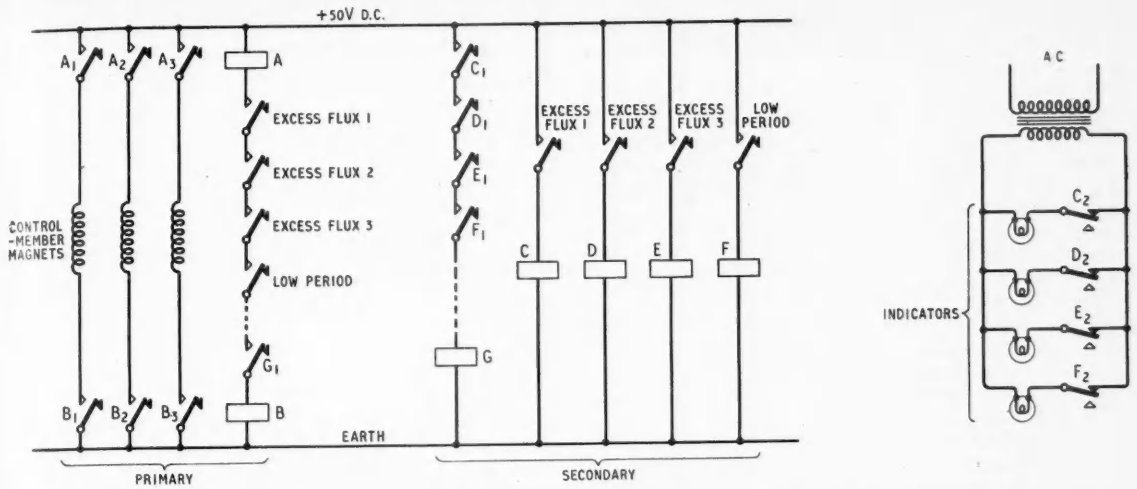
At operating levels it was desirable to measure the reactor power in terms of the heat output of the core and for short-term variations control had to be based on nuclear power; but the long-term control of the reactor would more likely be dictated by thermal reactions.

The paper went on to describe a number of nuclear measuring instruments starting with the ionisation chambers used for measuring neutron flux although these were more fully described in the third paper of the symposium. Some of the problems encountered in designing a suitable ionisation chamber were discussed and also the use of pulse counting neutron detectors such as the boron trifluoride proportional counter and the fission counter.

D.c. amplifiers were used for the measurement and indication of the main current from the ionisation chamber and three types were customarily used. The first of these known as the "multi-range linear" was a simple electrometer valve amplifier in which the ionisation chamber current developed a voltage across a measuring resistor connected between the amplifier input and output terminals. The second type was one in which the output voltage varied as a logarithm of the input current, the advantage of such an amplifier being apparent when it was remembered that a positive step in reactivity ultimately caused the neutron density and in consequence the ionisa-

**FAMILY TREE OF REACTOR INSTRUMENTATION**






*A simplified arrangement of shut-down circuits showing the duplication of the current interruption to the electromagnets*

tion chamber current to increase exponentially. The third type of d.c. amplifier was also a linear one in which the output voltage was compared with the reference voltage and the difference, which was a measure of the error between reactor power and demanded power, was displayed on a centre-zero meter.

For health purposes many radiation monitors were needed and a dozen or more gamma ray monitors might be in use on a large experimental reactor installation where it was customary to make continuous recordings of their outputs. Fast neutrons were some 20 to 30 times more damaging biologically than the same flux of slow neutrons and they were difficult to measure. The proton recoil counter had been developed but had a low counting rate and means of increasing the sensitivity were under study.

Safety and shut-off control members of the reactor were driven through reduction gearing by conventional three-phase induction motors, coupled to the gearing by magnetic clutches which had to be energised before withdrawal could be commenced. Regulating rod drives utilised velocity-controlled servo-motors on the amplidyne or velodyne systems. Some development work had also been carried out on the use of variable speed two-phase induction motors.

Many formidable problems existed in the application of automatic control to the regulation of reactor power before it had reached the demand level.

For safety purposes control operations had to be carried out according to a pre-arranged sequence and interlock circuits were arranged to ensure this. Certain faults were required to shut down the reactor automatically, as shown in the "family tree" diagram. Should one of these faults occur the relevant detector initiated a sequence of events terminating in the interruption of supply to the hold-on electromagnets of the control members, permitting them to drop into the core and shut down the reactor.

A skeleton arrangement of some typical shut-down circuits is shown above. All relays are normally energised when the safety lines are complete because the majority of faults likely to occur in the circuits or relays themselves will result in the relay coil being de-energised, in other words "failure to safety."

The author concluded that although much progress had been made in the development of special instruments and circuit techniques, the problems of overall control on power producing and propulsion reactors were still formidable and much experimental work was necessary.

The second paper was also on the control of nuclear reactors and was delivered by Messrs. R. J. Cox and J. Walker, of the Atomic Energy Research Establishment. This paper discussed at some length the physical principles of nuclear reactors which affected the design of their control and instrumentation. "Reactivity" was defined and the apportioning of units to it discussed. Different units had originated in different countries, that in use in the United Kingdom being the "nile" representing a reactivity of $10^{-2}$.

Changes in reactivity occurred inherently in a reacting system without control intervention and some of these were not advantageous; all had a significant place in the control of the reactor and the mode of its operation. These changes were due to burn-up of the fuel and the fact that changes in temperature of the reactor materials altered the reproduction constant. In general, temperature coefficients were negative and exerted a stabilising influence on the system. The recovery of the reactivity as the reactor cooled on shut down had to be allowed for in the design of safety and control devices.

An analysis was given of the way in which reactivity changes were controlled, this being the way in which the reactor itself was controlled. It was possible in the starting-up phase to make use of the stabilising influence of the temperature coefficients on power transients, and start-up rates were proposed which were sufficiently slow for the temperature controlled reactivity effects to keep pace with the power rise.

In considering the shutting down of a reactor it was pointed out that although in experimental reactors it had been common practice to date to reduce reactivity by as large an amount as possible as quickly as possible whenever a fault occurred, in some reactor systems this might cause more ultimate damage than that which had been prevented. For instance, in a submarine propulsion unit using a high flux thermal reactor a sudden shut down would cause the reactor to "poison-out" and immobilise the ship for up to two days. Reactivity could also be decreased at a uniform rate over a period of time. The authors of this paper showed graphically that the time taken to reach a few per cent of the initial power was very little shorter for a step change than for a slow rate of reactivity removal.

In discussing the reactor instrumentation system the reactor-period meter was explained. Neutron flux was displayed on a meter calibrated logarithmically so that

the pointer moved across the scale at a uniform rate. Differentiating the output of this indicator provided a signal giving a measure of the rate at which the pointer was moving and could be presented on a meter calibrated in reactor period, or doubling time. This signal could also be used to shut down the reactor should the period be excessively short and the instrument was the key one during the starting-up phase. In some reactors the full range of flux could be covered by one period meter (e.g. those using heavy water as a moderator) but more generally two meters were necessary.

## Ionisation Chambers

Nuclear reactor control ionisation chambers were described in the third paper of the symposium, presented by Messrs. W. Abson and F. Wade, both from the Atomic Energy Research Establishment at Harwell. This paper discussed in detail the design and construction of the new type RC/1 ionisation chamber developed for use in experimental and power reactors (see accompanying diagram). The electrodes and the cylindrical part of the outer case were spun from aluminium sheet held in compression against quartz insulators by means of a high tensile steel bolt. Insulation resistances in excess of $10^{15}$ ohms could be obtained if the quartz insulators were degreased and cleaned and care was taken to avoid contamination during assembly. Boron coatings approximately 1 mg/cm$^2$ thick were applied to the electrodes.

Thermal-neutron sensitivities of $10^{-15}/10^{-14}$ A/n/cm$^2$/sec could be obtained using boron trifluoride filling or boron coated electrodes with hydrogen filling. The corresponding gamma radiation sensitivities were of the order of $10^{-12}/10^{-11}$ A/r/h. Virtually complete collection of the ionisation current was possible up to neutron flux levels of $10^{11}$n/cm$^2$/sec with a polarising voltage of a few hundred volts. The residual current due to neutron induced activities in the chamber fell to less than $10^{-6}$ times the full power neutron current some 20 mins after shut-down.

A high degree of stability was essential in the neutron flux measuring channel used for the steady control of a reactor at full power and the boron coated chambers were to be preferred if the neutron flux level exceeded about $10^9$n/cm$^2$/sec, because of their superior ionisation collection characteristics. At the lower power levels existing during starting up it was more difficult to site ionisation chambers so that the current due to $\beta$ or $\gamma$ radiation was small compared with that due to the neutron flux and special measures were usually necessary.

Consideration had to be given to the effects of residual currents due to induced activity in the ionisation chamber. These limited the range of RC/1 chambers to about 6-7 decades for starting-up measurements between 30 min and 8 hours after a shut down. If two separate measuring channels were used, however, for starting up, one could be retracted once the reactor had been brought up to full power and in this way 8 decades of power level could be covered with an overlap of several decades between the two channels.

This type of chamber was expected to have several years' life in neutron flux levels as high as $10^{11}$n/cm$^2$/sec and $\gamma$ radiation dose rates of up to $10^5$ r/h. Radiation damage effects in polythene insulated cables had to be considered as it became hard and brittle after exposures of the order of $5 \times 10^9$ rads. It was preferable to use cables with an outer covering of polythene rather than polyvinyl chloride as the latter was less radiation resistant than polythene, became soft and evolved hydrochloric acid.

## Control Mechanisms

"Some Design Aspects of Nuclear-Reactor Control Mechanisms" by Mr. G. E. Lockett, also from Harwell, completed the four papers presented. This pointed out that although the safe control of a nuclear reacting system was of extreme importance a reactor should not be built unless it was inherently stable and would remain so under all considered conditions of failure. Also it was generally agreed to be better to accept a number of shut-downs due to faulty tripping than to run a risk of missing a genuine trip requirement.

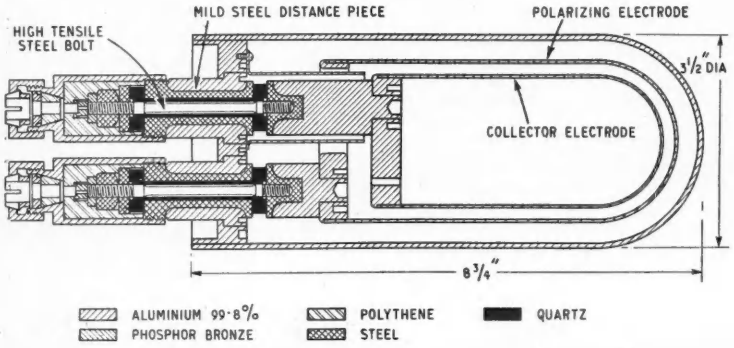
For thermal reactors the control elements were almost invariably absorbers, lowered into their shut-down position from above, and the reactor dimensions usually involved long travels between the full-up and full-down positions. Wire cable suspension was a suitable method of mechanically positioning the element and was often the only reasonable solution. The driving mechanism could be situated well clear by leading the suspension cable over pulleys. In small enriched reactors a noticeable change in reactivity could occur with lateral movement of a control element and accurate guiding became essential although this must not prejudice a free fall when elements were tripped. Problems of cooling could arise on control elements.

Within the high neutron flux regions of the reactor structural materials were limited to those permissible from a nuclear standpoint and all such organic materials as rubber, leather and oil would fail under neutron irradiation. These restrictions became less as the flux diminished and outside the immediate core shielding more conventional engineering became possible.

Among the overriding design aims to achieve safety were the points that, when tripped, control elements should fall freely to the shut-down position assisted by gravity which must always be sufficient by itself to overcome resistance: no common feature which might impair shut-down such as a common trip would be acceptable and fault tripping of any one element assembly must trip the remainder: the time required to achieve a trip shut-down must be sufficiently short to prevent undesirable heating effects due to power or temperature overshoots and for a controlled shut-down a slow approach to the sub-critical state was preferred in order to avoid rapid temperature changes. Other points were that groups of elements covering one particular function should move in parallel and at least two types of mechanism should be used in a complete control system.

The position of controls had to be shown on the control desk and on a power reactor the accuracy of indication did not need to be finer than a

*The type RC/1 ionisation chamber*



travel corresponding to the reactivity $\rho = 10^{-5}$ (an average of one-thousandth part of the travel of an element covering 1 per cent reactivity). Limit switches formed an essential part of the operation sequence and interlock circuits, and were invariably duplicated at end limits, each switch working in a different circuit.

When safety circuits were tripped to shut down a reactor, the shut-off elements were required to drop to the shut-down position with the shortest possible delay. An electromagnet with face-to-face contact was undoubtedly the quickest and most effective release; but for shaft-driven systems some form of magnetic clutch was required geared as directly as possible to the final winding shaft in order to minimise unwanted inertia.

Some reactors might need an accelerating system to speed the dropping of control elements. Systems were described in the paper using a compressed air accelerator and a hydraulic mechanism.

Braking and damping methods had to be devised to bring a falling control element smoothly to rest at an accurately known position. Some possibilities were electrical or eddy current braking, pneumatic or hydraulic damping, springs, friction braking or other energy transfer methods. The flywheel system was a simple one in which the flywheel was driven by the falling load and allowed to free-wheel at the end of the run. A variant of this system used at Harwell was described in detail in the paper.

Special problems were likely to be encountered in power producing reactors. In gas-cooled thermal reactors the pressures would not be too high to permit the use of re-entrant tubes reaching into the core and housing the control elements which could be operated by mechanisms mounted above each system. For high-pressure vessels or for reactors requiring fuel movement for control the elements would have to operate inside the core vessel but the control would have to be exercised from outside. Reactors using liquid metals under low pressure could be driven by induction motors with sealing shells between the stators and rotors and these could be released magnetically.

The detail engineering of mechanisms functioning inside closed vessels would require a considerable amount of thought. Many metallurgical problems would have to be solved and extensive testing of systems would be necessary to prove reliability before installation in reactors could be contemplated.

## DISCUSSION

The discussion of the papers was opened by Dr. Denis Taylor (A.E.R.E., Harwell) who commented on the paper by Abson and Wade, and said it was usual to site the ionisation chambers described in the paper in or near the reflector rather than in the centre of the reacting core. The ratio of the neutron fluxes at the location of the chamber and at the centre of the core might be of the order of 0·05 or less, and so it was necessary to consider whether that procedure was justified. Presumably, in the great majority of cases one was really interested in a flux measurement in the centre of the core, and so a measurement at or near the reflector to give an index of the flux at the centre was only permissible if that ratio remained reasonably constant.

The papers presented in the symposium were largely concerned with experimental reactors, and it would be of interest to know whether consideration had been given to the use of scintillation and Cerenkov counters to indicate reactor power in the low-power range. It was known that the gamma-ray spectrum of a swimming pool reactor showed a considerable flux of energy up to 8 MeV, so it should be possible to indicate reactor power by recording the flux of prompt-fission gamma rays and neutron capture gamma rays and by discriminating against fission product gamma rays. Such a gamma-ray detector would have some definite advantages over present neutron sensitive power indicators in that it would not be greatly affected by the neutron reflectors around the reactor lattice, and in some experimental reactors the detector could be more conveniently located further from the centre of the reactor, since the time required for gamma rays to reach the detector would be much smaller than that for neutrons.

The section dealing with the analysis of reactivity control rates in the paper by Cox and Walker was disappointing. There were several schools of thought about that matter. Originally, R. V. Moore proposed in connection with temperature stabilised start-up that the maximum rate of reactivity addition should be such that it was absorbed by the temperature rise. That was a very safe procedure, but it might, in fact, result in a start-up from shut-down to full power taking many hours. Many American authorities had a different philosophy. They considered the criteria for the maximum rate of reactivity addition in relation to the speed at which the protection system would operate to ensure a safe shut-down in the event of an accident, and they considered that there was everything to be gained by starting up the reactor as fast as possible consistent with that philosophy. At A.E.R.E. reactors were started up as a routine with reactivity addition at something intermediate between those rates, and that practice was apparently followed in many other places as well. It would seem that a very careful analysis of that problem would pay dividends. It would mean a relatively large amount of analogue computer analysis.

There was little in the papers on automatic control. That was reasonable as perhaps automatic control was less important with experimental reactors than with power reactors. However, it was noted that although automatic power level control had only been used experimentally on the present A.E.R.E. reactors, the new reactors which were in the course of construction, " Dido " and " Pluto," were to have automatic power level control. Presumably that was because it was necessary for the power level to be maintained steadily for long periods during experimental work.

It was interesting to note in Mr. Gillespie's paper and also in Mr. Lockett's paper the reference to safety circuit philosophy and the method of paralleling of shut-down amplifiers to avoid accidental failure during an equipment fault. One of the authors referred to the use of three shut-down amplifiers so that the operation of any two brought about a shut-down. Presumably the use of four shut-down amplifiers, operation of any three of which would result in a shut-down, would be safer but a more costly arrangement, and it was felt that the 3 : 2 arrangement was good enough.

Mr. K. Sandiford (U.K.A.E.A., Risley) said that the reactors at Risley were large production reactors as opposed to the smaller experimental reactors at Harwell, and the primary consideration was to keep the reactors operating safely for long periods at the maximum practicable power. It might be that difference in operating requirement which caused him to suggest a rather different relative emphasis between nuclear instrumentation and what, for want of a better term, was called physical instrumentation, from that given in Mr. Gillespie's paper.

Mr. Gillespie rather dismissed the physical instrumentation as being well known and as conforming to standard industrial practice. The physical instrumentation was certainly well known in the sense that it consisted in the measurement of quantities such as rate of flow, temperature, pressure and other commonly occurring variables

which had been measured for many years. However, any group responsible for the design of a power producing reactor which because of that fact dismissed the physical instrumentation lightly was, in his view, making quite the wrong approach to the general problem of reactor instrumentation.

It had been found from experience at Risley that the selection or more often the design of physical instruments and, equally important, the method of installation, were matters which required the very closest attention.

## Norwegian Investigations

Mr. P. Lion (Joint Establishment for Nuclear Energy Research, Oslo) referred to Mr. Lockett's statement that a high-pressure system using a coolant such as water would no doubt be best controlled by a direct drive using a multiple sliding-collar type of seal, which would provide a multi-stage pressure drop, and said that such a drive unit had been proposed for the boiling water reactor now being built in the United States. The approach to the problem in Norway had been from a different angle.

After some preliminary investigations of various possible designs, it was concluded that the most promising approach would be to try to develop a control element which was entirely enclosed and moved by magnetic forces penetrating a pressure wall. The construction of a prototype drive unit was being carried out in Bergen, and although it was too early to give details of the design, a few points might be mentioned.

The construction of the reactor was such that the control elements (cadmium rods) must be driven from above the reactor. The required movement was about 7ft and a pressure thimble—a non-magnetic stainless steel tube—of that height was mounted on the top lid. The thimble had an inside diameter of 60 mm, and the wall thickness of 7 mm. That rather thick tube was chosen in order to make sure that no mechanical damage could be caused to the tubes during the construction on the site. A plunger attached to the rod moved inside the thimble and an electromagnet was moved outside by a winch mechanism. The coil was energised by 6,000 AT and the force exerted on the plunger inside the pressure shell was about 30 kg.

The control element weight was 15 kg and the "stiffness" around the equilibrium position was measured to be about 1·4 kg/mm. The clearance to the wall with the magnet on was about 1 mm, and due to the special construction of the plunger the wall clearance was 2 mm when the current to the magnet was cut off. It had been found experimentally that the lag due to friction of the control element was better than $\pm 1$ mm at normal temperatures.

Dr. J. H. Mitchell (Ericsson Telephones, Ltd.) said he was appalled at the number of d.c. amplifiers with choppers which were in the system. He wondered whether the information which was now becoming available could not be applied to converting all the d.c. techniques to a.c. techniques with obvious simplification and increased reliability. Referring to the paper by Cox and Walker, in dealing with shut-down amplifiers, Dr. Mitchell said the authors suggested that more complicated means were now being looked at. In his limited experience every safety device relied for its safety on its inherent simplicity, and he wondered whether the authors were not going in the wrong direction.

Dr. van Zollingen (Naamloze Vennootschap tot Kevring van Electrotechnische Materialen, Arnhem) said that in the Netherlands preparations were being made to build a suspension reactor, zero energy experiments on which were about to commence. Many of the control problems mentioned in the paper by Cox and Walker were encountered in a power reactor of that type, but there were one or two outstanding advantages in respect of that particular reactor.

First, because the fuel was in the form of $UO_2$ particles of about 10 microns diameter, the fission products were shot out in the liquid ($D_2O$) and might be taken out of the system by a continuous purification process. That eliminated to a high degree the effects of iodine poisoning and the problem of start-up after any shut-down period. At the same time, the transient effects after a change of power level were greatly reduced. Continuous purification appeared to be possible by comparatively simple means.

Secondly, because of the very strong thermal coupling between the $UO_2$ grains and the liquid moderator, greater advantage might be gained from the very strong negative temperature coefficient than in other types of heavy water reactors. Thirdly, by pumping round the suspension, part of the delayed neutrons were emitted outside the reacting vessel. That would have a bearing on the controllability of the reactor as a whole, but its influence might be rather small when the speed with which they were pumped out was not too great.

Mr. R. J. Smith (G.E.C.) said it was interesting to note that while the fundamental function and operational distinction between experimental and power reactors was clearly stated, Mr. Gillespie expressed the view that as far as instrumentation was concerned, differences were mainly ones of detail. He wondered whether the author considered that to be a satisfactory state of affairs. In particular, perhaps the time had come when it should be possible to reduce the scale of neutron-flux instrumentation in power reactors. Cox and Walker emphasised that the significant application of neutron-flux measurement was in the sub-critical state while the short-term control function was also important. Trips operating from excess flux and possibly low period would be required, but a multiplicity of recording and indicating instruments seemed unnecessary at power levels.

The relationship between the three parameters, neutron-flux iron chamber current, effective neutron flux throughout the reactor and total heat production in both steady state and transient conditions, could provide interesting food for thought and speculation as to calibration of instruments and arrangements for automatic control.

The value of an analogue computer in solving control problems was stressed in the paper by Cox and Walker. When control of a complete reactor power plant was being investigated it would certainly appear that transfer function analysis, though giving useful information on system stability and the required characteristics of correction networks, had its limitations. In particular, the analogue computer was ideally suited to the determination of transient excursions in temperature and other parameters under various fault conditions.

Mr. R. Parr (Metropolitan-Vickers) said it was true that temperature coefficients had a profound effect on the dynamic performance of reactors. Of particular significance also was the time relationships between power changes and temperature changes. It was rather surprising, therefore, to notice Messrs. Cox and Walker introducing the concept of an equivalent power coefficient. Except in very special cases one would have thought that that method of approach was so crude as to be almost worthless.

With regard to delayed neutrons, they were very useful things to have in a reactor, for they exerted a potent stabilising effect. What he would query was that a reactor without delayed neutrons was in fact uncontrollable. He would have thought that it depended on the reactor characteristics and in particular on the magnitude of the temperature coefficients and of the time lags between power

and the appropriate temperatures. In general, however, he did not agree that a reactor without delayed neutrons was uncontrollable, otherwise there would be little hope of success for some of the circulating fuel reactors proposed by the Americans.

A simple method of considering a reactor for the purpose of assessing its control characteristics was to regard the reactor as a closed loop system in which the reactivity of the system was controlled. The net reactivity could be regarded as the error of the system which, under steady state conditions, was zero. By visualising the reactor in that manner one could appreciate the effect on the dynamic performance of the reactor of factors such as thermal time lags, temperature coefficients, delayed neutrons and fission product poisons. One could also appreciate that conditions could exist in which the reactor was unstable in the automatic control sense, that is, the power was oscillatory. It was, of course, important to appreciate that such a model was approximate only and should be applied with discretion. For an accurate assessment of the dynamic characteristics the complete set of equations governing power, temperature, poisons, etc., must be analysed in detail.

Mr. J. H. Bowen (U.K.A.E.A., Risley), commenting on Mr. Lockett's paper in which he surveyed the requirements, said he found a general inclination to rely on interlocks to provide foolproof operation. That seemed to transfer the responsibility for safety from the operator to the maintenance engineer. The policy of the Industrial Group would be to place responsibility for the integrity of shielding, the provision of cooling and the raising of safety rods on the shoulders of the operator who would have to be trained to do those things.

Mr. Stonehouse said that in designing control mechanisms for pressurised gas-cooled reactors, the choice had to be made between mounting the main actuating members outside or inside the vessel. If the actuating mechanism were mounted outside the vessel, the principal problems arose in connection with the design of a suitable seal for the shaft transmitting the driving torque through the pressure vessel wall. That seal should have a low frictional drag on the shaft so that operation on shut-off duty was not restricted and yet be gas tight. The design of such a seal presented many problems.

If, however, the alternative choice of mounting the whole of the mechanism inside the vessel were made, difficulties arose in reconciling the requirements of utter reliability and infrequent maintenance with high working ambient temperatures. The need arose for motors, clutches, limit switches and position transmitting syndros which would operate at temperatures which might be in the 150 to 200 deg C range. Further there was a severe bearing problem as not only must the bearing material and lubricant withstand that temperature without serious deterioration, but the lubricant if used should not contaminate the circulating gas. As a consequence, impregnated and self-lubricating type bearings were normally used. That influenced the design so that the mechanisms inside the vessel were made as simple as possible even if that resulted in increasing the complexity of the associated external electrical control gear. Such external electrical equipment could operate under normal conditions and could far more readily be made fail safe and reliable.

Contributions to the discussion were also made by Mr. R. V. Moore, Monsieur Weill (Commissariat à l'Energie Atomique), Mr. H. H. Heath and Dr. Birch.

# Earth Loop Resistance Tester

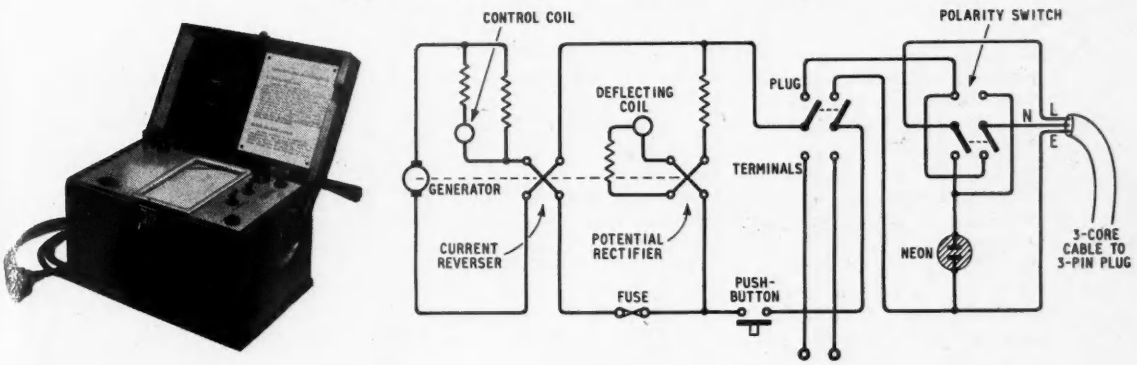
AN instrument has been designed by Evershed & Vignoles, Ltd., to meet the requirements for earth loop resistance testing arrived at as a result of research described by Dr. G. F. Tagg in a letter published in this issue.

The testing supply is obtained from a hand driven generator, and the measurement is made by a moving coils ohmmeter. Since a hand generator is used, the power available is limited, and this can be assumed to be about 30 W maximum. If then the generator is wound for 10 V, this means a current of 3 A maximum, which will then be the current passed through the external circuit when this is of zero resistance. If the external circuit has a resistance of 1 ohm, the current is 2·3 A, at 2 ohms 1·88 A, etc. The instrument passes reversed direct current through the test circuit, the frequency of the reversals depending on the speed at which the generator handle is turned.

The principle of the instrument is as follows. Direct current from the hand generator passes through the shunted control coil of a moving coils ohmmeter to a current reverser mounted on the generator spindle, and thence through the earth loop. The current actually traversing this loop is thus reversed direct current, and produces a voltage drop of a similar nature. This voltage drop is applied to the deflecting circuit of the ohmmeter, and produces a current through the deflecting coil, this current being first rectified by the potential rectifier also mounted on the generator spindle and running in synchronism with the current reverser.

The position taken up by the moving system of a moving coils ohmmeter, and hence the indication on the scale, is dependent only on the ratio of the currents in the two coils. In this case one coil is carrying a current proportional to the testing current, and the other a current proportional to

*"Megger" Series I earth loop resistance tester and circuit diagram*



the voltage drop across the resistance under test. The ratio of these two currents is dependent only on this resistance, and the instrument is accordingly calibrated to read resistance directly.

As already stated, the frequency of reversal of the current is under the control of the operator as it depends on the speed at which the handle is turned. The voltage drop already existing in the neutral conductor will tend to pass currents through both circuits of the ohmmeter. The currents are of power frequency and are rectified by the reversing commutators. If the latter are running at some frequency other than the power frequency, then the net rectified current is zero, and the instrument is unaffected by the presence of the voltage drop in the neutral conductor, which can accordingly vary in phase and magnitude during the test without producing any error. When a test is made the pointer of the instrument may waver, showing that the frequency of reversal is too near the frequency of the power currents and it is then necessary to increase the handle speed and consequently the frequency of reversal until the pointer is steady.

A warning lamp and change over switch are fitted to ensure that the instrument is connected to neutral and earth. In addition, means are provided to enable additional tests to be made at currents approximately one-tenth of those quoted earlier. Another point in connection with this instrument is that since the testing supply comes from its own generator, a measurement can be made before the main supply is connected, provided the neutral and earth continuity conductors are complete.

# Crystal Palace Television

THREE papers relating to the B.B.C. television station at the Crystal Palace were presented on 4th April before the Radio and Telecommunication Section of the Institution of Electrical Engineers. One, by Messrs. F. C. McLean, A. N. Thomas and R. A. Rowden (B.B.C.), gave an account of the factors which determined the siting and design (with reliability as a primary consideration) of the new installation, which was described in detail. Reasons for removal from the Alexandra Park site, mainly to secure a greater coverage, and for the choice of effective radiated power and aerial gain were discussed. Particulars of the construction and performance of the aerial system were also given. The main features of the station were set out in an article in last week's issue of the *Electrical Review*, page 526.

Another paper by Dr. A. R. A. Randall and Mr. S. H. Padel (B.B.C.) was concerned with the Broadcasting House-Crystal Palace television link. This consisted of one channel in each direction, though a second channel was likely to be required later. Transmission of two programmes over a single tube was stated to make 0·975in coaxial cable economic over the distance of 9 miles without calling for intermediate equipment. A double-sideband system with amplitude modulation had been developed, but to provide for a later wider-band channel for colour the carrier frequency of the monochrome channel had been placed at 15 Mc/s. The performance of the link was given in terms of measured amplitude and differential delay characteristics, transient response, linearity and signal/noise ratio.

In the third paper the design of the television transmitter, which was operated in two parallel chains to ensure reliability, was dealt with by Messrs. V. J. Cooper and W. J. Morcom (Marconi's Wireless Telegraph Co.). The vision transmitters were intended to work with considerable distortion and noise in the input signal. The use of tetrodes in the output stage enabled receiver-type valves to be employed throughout the modulator, thus permitting high-level modulation. Methods of phasing of both radio and vision frequencies were described.

The discussion was opened by Captain C. F. Booth, who said that as a result of the bold step of transferring the well-founded service from Alexandra Palace to the Crystal Palace, there would be two million more viewers. Colour television was still some way off. The inclusion of a clause in the specification about the N.T.S.C. system did not imply the use of that or any other colour system.

Dr. B. Van de Pol said he had been informed that slot aerials were used in new f.m. transmitters, whereas in the television transmitters the classical half-wave dipoles were used in proper combination, phasing and spacing. Was there any electromagnetic reason for that, he asked, or was it just a constructional question.

Mr. C. E. Strong questioned the advisability of parallel operation of transmitters in the present case, though no doubt it paid well with high-power broadcasting transmitters. Although a fault did not cause even a momentary interruption of the programme, two transmitters had to be lined up for equal performance at the same time; the number of components in service was nearly double; and there might be extra complexity in phasing the video and radio frequency circuits. It might have been better to go for two transmitters of full power, one in operation and the other in reserve with cathodes partially on, ready to be switched over automatically and instantaneously.

Mr. C. J. Hirsch reported that it had long been debated in the United States why in general British pictures looked so much better, though they should not do so. Clearly the field strength was adequate, attention was paid to the waveshape and care was taken that all parts of the picture got where they should at the proper time.

Mr. I. F. Macdiarmid described waveform tests on the Crystal Palace television link, using the G.P.O. method of measurement for testing television links and as a means of specifying new links. With this method a rating factor was obtained for different features of the distortion of the waveform of a standard transmitted test signal. These tests confirmed that the overall rating factor of 0·4 per cent was very good indeed.

Dr. C. T. H. Van der Wijk pointed out that the United Kingdom had been the first to introduce a regular television service for the public. This had forced engineers to face the basic and practical problems and given them a mastery of the art which had been of inestimable value to experts and organisations in other countries.

Sir Harold Bishop recalled the paper on Alexandra Palace by Macnamara and Birkinshaw in 1938 and paid tribute to Sir Noel Ashbridge who had done so much to help get that station on the air. The initial power of the Crystal Palace transmitter was only twice that of the Alexandra Palace design. He thought the McLean paper disposed of the question of balance between aerial gain and transmitter somewhat too quickly and asked why it was decided that the best compromise was eight tiers for the aerial. He did not think that 100 $\mu$V per metre would be adequate for all time and thought the figure would prove to be more like 250 $\mu$V. The choice of a site was most important, and there was no doubt that the new station would cover a million to a million and a half more people, simply because there was more adequate coverage.

# Pyrmont 'B' Power Station

## *Completion of New South Wales Plant*

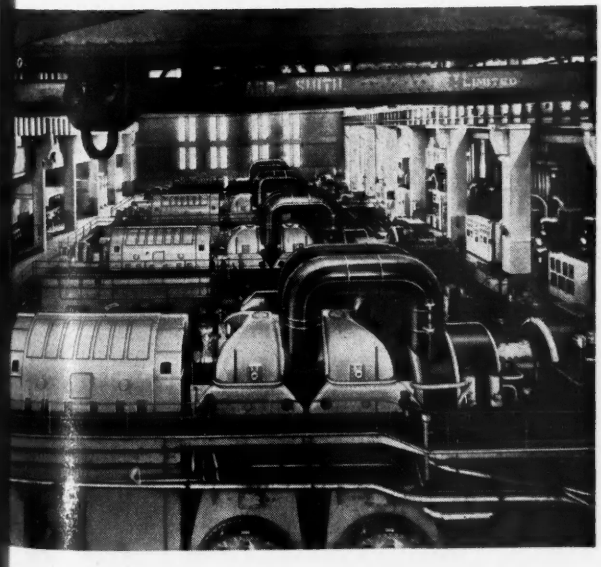
FROM A CORRESPONDENT

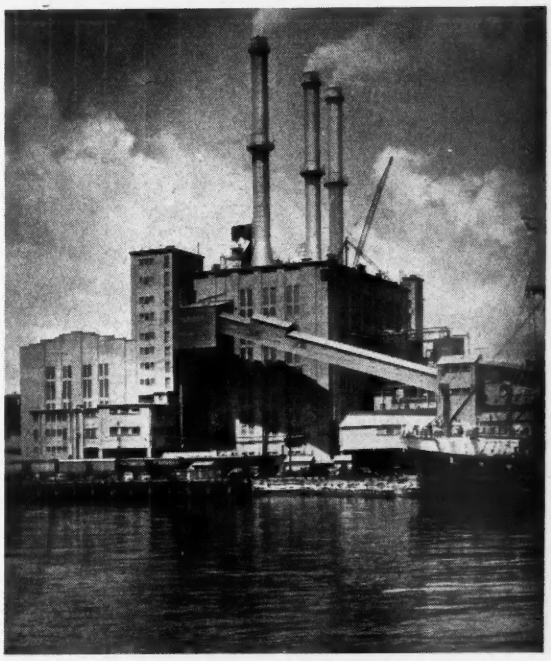
IN August, 1955, the final section of the plant at the Pyrmont "B" power station of the Electricity Commission of New South Wales was placed in service, bringing the total installed capacity to 200 MW, and the station has recently been officially inaugurated.

Apart from the high pressure superposed turbine installed in the Balmain power station in 1947, Pyrmont "B" is the first relatively high pressure plant to be commissioned in Australia. It contains four boilers, each of 430,000 lb/hr capacity at 1,250 lb/sq in and 950 deg F. Each boiler supplies a 50 MW turbo-alternator and although the boilers and turbines are interconnected on both the steam and feed water side, the normal practice is to operate on the "unit" system with each boiler supplying steam to one turbine only. The boilers are of the Lopulco radiant heat type supplied by International Combustion, Ltd. The steam pressure at the superheater outlet is 1,280 lb/sq in and the temperature of 950 deg F is controlled within specific limits by interstage desuperheaters.

The combustion chamber is lined with finned tubes, the rear wall tubes being staggered at the gas exit from the furnace to provide a slagging screen. Coal burners are of the tangential tilting type, one burner being placed in each corner of the furnace. Each mill has an outlet to each of the four burners so that symmetrical firing conditions are maintained regardless of the number of mills in service.

*The completed turbine room with four 50 MW sets*





*External view of the Pyrmont "B" station*

The tilting of the burners may be employed to control superheat temperature but automatic superheat temperature control is additionally provided in the form of non-contact type desuperheaters situated between primary and secondary sections of the self-draining superheaters. The pulverising equipment provided for each boiler comprises four mills complete with feeder and exhauster and provision for classifying the coal.

Three-stage Lodge-Cottrell twin precipitators each equipped with 25 kVA rotary disc rectifier and transformer are mounted at the fan floor level. The maximum gas velocity is about 5ft/sec. The precipitator hoppers of approximately 100 ton capacity project below the fan floor into the boiler room, but are separated from the boiler house proper by means of a dust-tight chamber. The precipitator treater chambers are housed in a welded steel casing.

Each turbo-alternator has a continuous maximum rating of 50 MW at 0·90 power factor and operates at 3,000 r.p.m. Generation is at 33 kV. The Metropolitan-Vickers turbines are of the three cylinder, impulse type, and are designed for maximum efficiency at rated output with a steam pressure of 1,200 lb/sq in and a temperature of 925 deg F at the turbine stop valve.

Provision is made for coal handling either by road or rail into the station, separate hoppers being provided for road and rail deliveries. Rail trucks are unloaded either by gravity or by grab cranes of a capacity of 160 tons/hour.

From the road and rail hoppers, coal is elevated into the station by conveyors, duplicate belts of a capacity of 200 tons/hour being provided. Magnetic pulleys are provided for tramp iron separation, and automatic belt weighers are fitted to those conveyors which feed on to the tripper belts above the boiler-house bunkers.

Furnace ash and dust from all points on the boiler are handled by a pneumatic conveyor system using motor driven centrifugal exhausters, the equipment being supplied by B.V.C. Industrial Constructions. Three stages of separation are used to remove the ash and dust from

*Plant control room*

the conveying air, the final stage being automatically shaken bag filters. The dust handling system is controlled from a central control room and the controls for furnace ash handling are adjacent to the furnace ash hoppers. From storage hoppers in the ash and dust handling building the refuse is fed to inclined rotating drum conditioner conveyors where it is wetted by spraying and then loaded into road vehicles for haulage from the site.

The circulating water conduits of reinforced concrete are rectangular in section with a dividing wall designed to permit emptying on either side for inspection and cleaning. For this purpose, provision has been made for the insertion of bulkheads at various points in the system.

A portion of the intake conduit which will serve both the old and the new power stations has been designed for a flow of 512 cu ft/sec and the remainder of the system for a flow of 440 cu ft/sec, the velocities being 4·8 and 4·6ft/sec respectively. Chlorine is used to combat minute algæ in the cooling water system and condensers and to prevent the formation of marine growths on the walls of the intake conduit.

From the plant control room boilers, turbines, and auxiliary plant are remotely controlled. Starting of a unit is supervised on the operating floor, but after the unit has been synchronised in the electrical control room, the running of the boiler and turbine plant is taken over by operators in the plant control room.

The safe starting-up and shutting-down of the high pressure and temperature turbines has been greatly facilitated by the use of turbine supervisory equipment which indicates and records turbine rotor position relative to the casing and rotor eccentricity. This equipment is located on the turbine operating floor, from which start-ups and shut-downs are supervised.

The steam cycle chosen for this plant, namely 1,200 lb/sq in and 925 deg F at the turbine stop valves, has resulted in a high station thermal efficiency, and for the year ended 30th June, 1955, this averaged 30·05 per cent on a generated basis and 28 per cent on a sent-out basis. This has been achieved with coal of an average gross calorific value of 10·95 B.Th.U/lb on an "as fired" basis.

# National Research Development

IN the report and statement of accounts of the National Research Development Corporation for the year ended 30th June, 1955 (H.M. Stationery Office, 1s), a number of new development projects are mentioned and there are progress reports on work initiated during previous years. For instance, the possibility of controlling machine tools directly by a digital computer has led the Corporation to support an extended design study in this field which is to be carried out by the Manchester College of Technology. Of the six big computers referred to in the last report, four have been delivered, installed and accepted, while ten smaller machines have been ordered for delivery during the next two or three years. Grants for training computer engineers continue to be made to Manchester and Cambridge Universities but the response is small.

Among the new work mentioned in the report is an ingenious system of electron-optics which has been proposed by Dr. T. Gabor, Mullard Reader in Electronics at the Imperial College of Science and Technology. The design, which eliminates the "stalk" of a cathode ray tube, should lead to a much more compact and flat product. This will enable television receivers to be made with more reasonable proportions and without the undesirable but, for the present necessary, protuberance at the back. This development should also simplify the problem of colour registration in colour television receivers.

Included in the Corporation's portfolio are a number of other public inventions which have not required development expenditure by the Corporation and are being exploited by industry. Among these is a method of cutting aluminium and its alloys, evolved by Mr. D. R. Mackie at the Admiralty, which employs an electric arc surrounded by argon gas and uses a consumable electrode. The technique is more flexible than the mechanical methods previously employed, but a high current density is required. A British and American firm are licensed to operate this process, which may have considerable application in industry.

Another invention which has been exploited by the Corporation was devised by Mr. R. Kompfner when he was employed by the Admiralty. This is a backward travelling wave tube which is a form of electronic valve for generating oscillations at ultra-high frequencies. It has the particular virtue that it can be tuned by varying the operating voltage. These tubes are used for microwave links in television distribution networks.

Another interesting device is an improved form of exploder devised by Mr. W. A. Mutter of the Ministry of Supply. It comprises a manually driven a.c. generator and avoids the use of a battery or rotary d.c. generator. Exploders of this type are used on a substantial scale in mines and quarries and are sold under N.R.D.C. licence.

## Gas-Turbine Fuel Flexibility

IN a paper presented by Messrs. G. B. R. Feilden, J. D. Thorn and M. J. Kemper (Ruston & Hornsby) before the Institute of Mechanical Engineers on 6th April an account was given of the development of a 750-1,000 kW gas turbine designed to run on fuels ranging from natural gas and gas oils to residual fuels, coal tar and peat. Details were given of a range of combustion chambers to burn such fuels which can be fitted interchangeably on the basic components of standard turbines. The paper described the development of a chamber of the elbow type from early atmospheric test models to pressurised production types and also a special form of construction for dealing with high temperatures encountered when a gas turbine is started and put on load rapidly.

# GENERATION AND DEVELOPMENT

### *Revised South Wales M.D. Tariffs*

The South Wales Electricity Board has announced changes in its industrial and commercial maximum demand tariffs. These tariffs were introduced in April, 1952, and the present variation is the first which has taken place since that date. The new charges represent an increase which reflects the general rise in costs including the capital cost of new power station construction over the past four years.

Under the former commercial and industrial tariffs the m.d. charge was £5 7s 6d per kW for high voltage supplies and £5 17s 6d for medium voltage supplies. The new charges will be as follows:—

| | *Medium Voltage* | | *High Voltage* | |
|---|---|---|---|---|
| | *Year* | *Month* | *Year* | *Month* |
| Up to 200 kW | £7 0s | 14s | £6 10s | 13s |
| 201 to 500 kW | £6 15s | 13s 6d | £6 5s | 12s 6d |
| 501 to 1,000 kW | £6 15s | 13s 6d | £6 0s | 12s |
| Over 1,000 kW | £6 15s | 13s 6d | £5 15s | 11s 6d |

The annual maximum demand charge will in future be related to a moving twelve months instead of to a fixed year of supply.

The "unit" charge is now associated with an up-to-date fuel cost (60s per ton instead of 38s) and the fuel price variation will be 0·00065d for high voltage supplies and 0·0007d for low voltage supplies. The opportunity is also taken to introduce stepped charges which will give a further benefit to consumers with good load factors. The new "unit" charges are as follows:—

| | *kWh per kW of m.d.* | *Medium voltage* | *High voltage* |
|---|---|---|---|
| Primary rate | First 1,500 | 0·86d | 0·82d |
| Secondary rate | Next 2,000 | 0·81d | 0·77d |
| Final rate | Excess | 0·76d | 0·72d |

Charges under the industrial tariff will be subject to power factor adjustment which will involve a penalty for consumers with an average power factor of less than 0·8 and a bonus for consumers whose average power factor is greater than 0·9. The industrial tariffs also include a proviso that the maximum charge shall not exceed 2¼d per kWh (or in the case of high voltage supplies 2¼d per kWh less 10 per cent).

Similar adjustments are to be made in the case of special agreements.

### *Peat Power Station*

The first power station in Western Europe to use milled peat to produce electricity will be in operation within twelve months. It is being constructed for the Irish Electricity Supply Board at Lumcloon, on the Silver River, four miles south of Ferbane, Co. Offaly. Irish fabricated steel is being used, and the construction work, in which thousands of tons of this steel will be used, is being carried out by Irish firms. The station will derive its power from three milled peat-fired boilers with an output of 220,000 lb/hr driving three 20,000 kW steam turbo-generating sets. The electricity output will be about 240 million kWh a year.

### *Gas Turbine Power Station*

A 10,000 kW gas turbine power station at the Ministry of Supply's National Gas Turbine Establishment, Pyestock, Farnborough, Hants, was successfully synchronised with the national grid system recently. The gas turbine, which has been constructed by C. A. Parsons & Co., Ltd., is of the open-cycle, two-line type, with intercoolers, running on liquid fuel.

Waste heat from the exhaust gases is being made to provide site heating for the Establishment through a district heating system. This is the first time such a system has been used with a gas turbine and enables an overall efficiency of 40 per cent to be obtained.

The station has been built mainly for studying problems associated with the industrial application of the gas turbine and the electricity generated will supplement the supply from the grid for the research and development of gas turbines.

### *Electricity v. Solid Fuel*

The Council's policy regarding domestic equipment and the Board's charges for supplies to the Horden Dene Estate have been the subject of recent correspondence between the North Eastern Electricity Board and Easington R.D.C. The Board complained of the Council's decision not to install electric cookers in Council houses, stating that since the war it had spent £116,000, without any cost to the Council, in providing electrical services. It was not economic to provide this expensive equipment unless appliances were used. A recent survey carried out in County Durham had shown that an ordinary Council house equipped with electric cooker, wash boiler and the usual small appliances had an annual fuel bill of about £12. This, it was thought, was competitive with solid fuel. The Board also had a scheme for collecting electricity bills in fortnightly instalments. In certain areas, where the supply had been taken over from the National Coal Board, the Electricity Board had installed cookers in houses already fitted with a solid fuel range. The Board contended that many tenants preferred to have electric cookers installed. The Council promised to give the Board's representations "careful consideration."

In the case of the Horden Dene Estate, the Council is responsible for the whole of the overhead network and also the meters installed in each of the 53 houses. Consequently, when the Board announced an increase in charges the Council suggested that there should be a special tariff for this estate to compensate the Council for its expenditure in maintaining the overhead wiring and collecting payments, or alternatively that the Board should take over both these functions. The Board has not only rejected the Council's proposals but has announced that a charge of 10s per meter will be made for recalibrating meters to the new scale of charges. The Council has decided to pursue the matter at a higher level.

### *Supply to Borrowdale*

The North Western Electricity Board has decided to go ahead with its plan to supply electricity to the Borrowdale area of Cumberland, and the work is not to be delayed by the Government's restrictions on expenditure. Plans for supplying Borrowdale were first drawn up about 30 years ago. The work will be done in stages over a period of about three years. There has been some opposition to the plan from the National Parks Commission because it involves the erection of overhead lines.

### *Expansion in Ecuador*

To assist in the financing of a scheme for trebling the supply of electric power in Quito, the capital of Ecuador, a loan of $5 million is being made by the World Bank. The loan will enable the Empresa Electrica Quito to import from abroad generating plant, transformers, cable, switchgear, etc. The total expenditure upon hydro-electric and thermal power development will be about $9 million.

### *Street Lighting Plan Deferred*

Since inviting tenders for its £189,000 scheme for installing sodium lighting along residential roads in the borough, Wandsworth Council has received a Ministry circular indicating that for at least six months there will be a virtual embargo on all new capital projects or expansions of existing schemes which can be deferred without risk to health, safety, or other vital interests. In the circumstances the Highways Committee recommends that the plan should be postponed.

### *Chilean Railway Electrification*

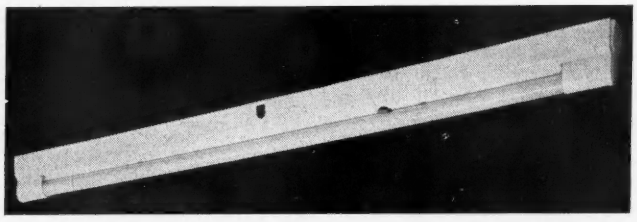
The *Fortnightly Review* of the Bank of London and South America reports that it is expected that the Chilean State Railways Administration will shortly call for tenders for the electrification of the line between Santiago and Chillán. The cost has been estimated at U.S.$27 million and the plan would include, besides track electrification, the purchase of locomotives and railcars.

# NEW ELECTRICAL EQUIPMENT

## Fluorescent Fitting

A new 80 W 5ft single-lamp, fluorescent fitting for the industrial market has been introduced by PHILIPS ELECTRICAL, LTD., Century House, Shaftesbury Avenue, London, W.C.2. It is known as the "Boston" (A6630) and is sold at a list price of 4 gns (excluding lamp).

The new fitting is finished in white stove-enamel, and may be ceiling mounted, or suspended by rod or chain. There is provision for the attachment of a "Perspex" diffuser if required.

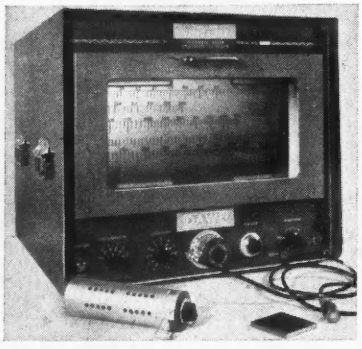


*Philips "Boston" fluorescent fitting*

## Ultrasonic Thickness Gauge

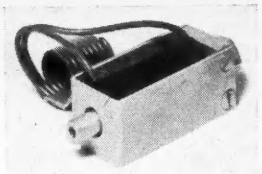
Extending their range of ultrasonic thickness gauges, a new model, the Type 1107B "Visigauge," has been introduced by DAWE INSTRUMENTS, LTD., 99, Uxbridge Road, London, W.5. This operates on the ultrasonic resonance principle by which the thickness of components, of which only one side is accessible, can be measured non-destructively. High accuracies can be obtained: direct-reading scales are available for the measurement of thicknesses between 0·005in and 2·5in with an accuracy of between ±0·0005in and ±0·003in. Even higher accuracy can be achieved over limited ranges and measurements to within 0·1 per cent of the actual thickness can be obtained for some applications. The thickness of all metal components can be obtained, even of such heavily damped materials as lead. Readings can also be taken on a wide variety of non-metallic objects, successful measurements having been taken on graphite, plastics, glass and even solid argon.

*Dawe "Visigauge" for the non-destructive measurement of thickness*



## Miniature Solenoid

The first of a new range of miniature solenoids developed for the electronic and accounting machine industry has been produced by the VARLEY MAGNET CO., Cambridge Row, Woolwich, S.E.18. The first of these is known as the "S.M.O." These miniature solenoids are available for use on either a.c. or d.c. and can operate approximately 300 times per minute depending on the particular application.

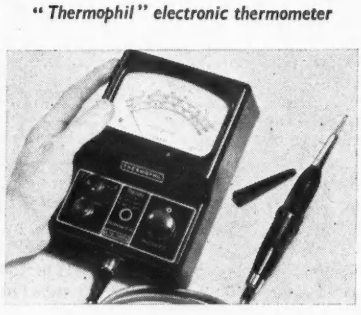


*"S.M.O." miniature solenoid*

## Electronic Thermometer

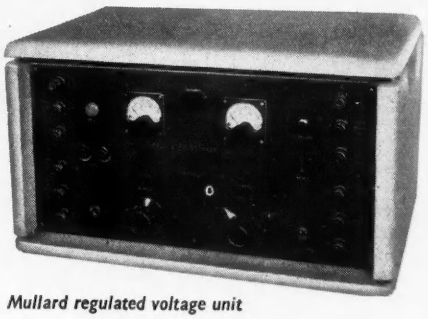
A new German instrument is now available in this country from HEADLAND ENGINEERING DEVELOPMENTS, LTD., 164-168, Westminster Bridge Road, London, S.E.1. This is the "Thermophil" electronic thermometer which enables the temperatures of solids, liquids, emulsions, powders and gases to be measured very quickly with an accuracy of the order of ±1 deg C. The instrument is quite small and weighs less than 2¼ lb. It operates from 1½ V and 22·5 V internal dry batteries with a life of six to twelve months in use. The probe element is a germanium base alloy semi-conductor 0·25 mm in diameter enabling heat exchange to be effected very rapidly and minimising the actual heat extracted. Extension cables of any length can be fitted. The four instruments that are available at the moment are scaled respectively (C) 25 to 45 deg, −10 to +110 deg, −50 to +160 deg and 0 to 210 deg. On request calibration can be arranged in Fahrenheit degrees.

*"Thermophil" electronic thermometer*



## Regulated Voltage Unit

A regulated voltage unit, the L.153, is a general purpose laboratory power unit produced by Mullard, Ltd., Century House, Shaftesbury Avenue, London, W.C.2. It provides a stable low impedance d.c. supply continuously variable between 0 and 300 V at up to 300 mA. Two 4 A a.c. supplies of 6·3 V, tapped at 4 V, are also incorporated, as well as an unregulated e.h.v. supply of 1·2 kV at 2 mA. The d.c. outputs of two units can be connected in series to give up to 600 V positive and negative to earth.



*Mullard regulated voltage unit*

The variation in output voltage is less than 100 mV for mains variations of +10 per cent to −15 per cent. Ripple voltage is less than 3 mV, and output resistance is about 0·2 ohm. The 1·2 kV output can be either positive or negative with respect to the negative terminal of the 300 V supply. It can be used for cathode ray tubes, Geiger Müller tubes, photo-multipliers, etc.

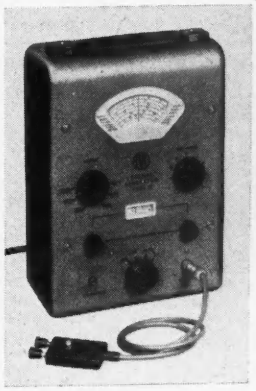
Output voltage and current meters are incorporated, and the unit is protected against overloads by a circuit-breaker which lights a warning lamp. This circuit-breaker may be reset by operating a push-button on the front of the unit.

## Tramp Metal Detector

An improved development in removing tramp metal is the combination of a metal detector and a magnet

in a combined unit. This has been introduced by METAL DETECTION, LTD., Moseley Street, Birmingham, 12. In this combination the magnet carries out its normal function of attracting and removing ferrous contamination and one detector operating in conjunction with a special rectifier unit controls the excitation of the magnet windings, so that maximum saturation takes place only when an unusually large piece of iron is encountered.

The advantages gained from this arrangement are that the temperature rise of the magnet windings is minimised, current consumption is lower and a greater magnet efficiency is obtained when tramp iron is actually within the range of the magnet. A secondary detector, forward of the magnet, functions as a gleaner and stops the belt to permit removal of manganese digger teeth and other damaging non-ferrous bodies.



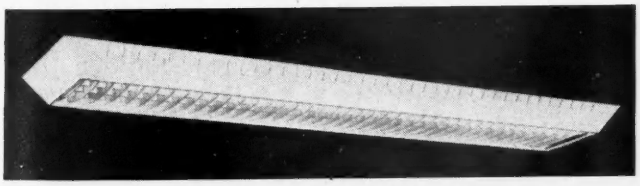
*"AVO" signal generator*

### Store Lighting Fitting

A new fluorescent store lighting fitting (HJ/HJQ 2080) is announced by the "Atlas" Lighting Division of THORN ELECTRICAL INDUSTRIES, LTD., 105-109, Judd Street, London, W.C.1. It accommodates two 5ft 80 W tubes, and has sloping metal sides finished in "Portland Stone" enamel, which support a white enamelled metal louvre with a curved underside emphasising the slim lines of the assembly. A series of vertical slots in the frame add sparkle to the appearance.

The fitting combines direct downward lighting with a substantial degree of evenly distributed upward light, and is suitable for lighting departmental stores. The metal louvre is easily removed for cleaning purposes.

The price, complete with control gear, is £16 10s plus £2 4s 9d purchase tax in the United Kingdom.



*Above: "Atlas" HJ/HJQ 2080 fluorescent store lighting fitting*

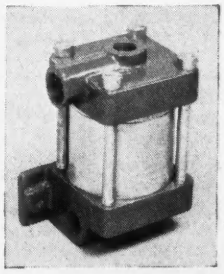
### Tropicalised "Avometers" and Signal Generator

Specially constructed models of the numbers 7, 40, 8 and 8(S) "Avometers," with the suffix "X," for use in areas having high relative humidity, have now been produced by the AUTOMATIC COIL WINDER & ELECTRICAL EQUIPMENT CO., LTD., Winder House, Douglas Street, London, S.W.1. Certain components within the instrument have been "potted" in an epoxy casting resin to render them impervious to moisture. A different material is used for the moulded panels, to reduce leakage due to moisture absorption and to provide greater resistance to fungus growth.

A new signal generator has also been introduced by this company, intended for radio and television servicing and covering a continuous frequency band from 150 kc/s to 220 Mc/s.

### Armoured Cable Gland

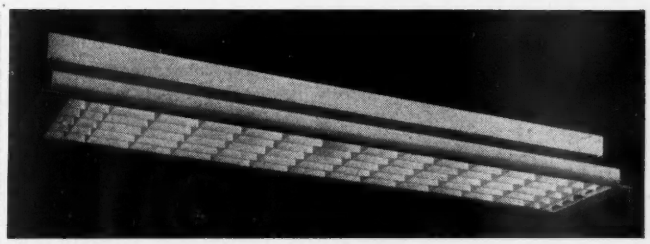
A recent addition to the existing range of cable glands manufactured by the FAIRLESS ENGINEERING SUPPLIES CO., LTD., Fesco House, Bishopton Lane, Stockton-on-Tees, is a new type of armour bonding and sealing gland for use on p.v.c. and armoured cables. It can be fitted to any type of p.v.c. cable and its simple design allows a termination to be made with ease. The armour wire is rigidly bonded by means of a brass cone and sleeve, and the cable is made watertight by a compression nut on a rubber washer, or cold sealing compound, as desired. The range will accommodate all sizes of cable, the shank being screwed with conduit thread from $\frac{3}{4}$in to 3in, and brass locknuts can be supplied.



*Right: "Fesco" armoured cable gland*

### Fluorescent Fittings

Two "Mazda" 5ft recessed fluorescent fittings have been introduced by the BRITISH THOMSON-HOUSTON CO., LTD., Crown House, Aldwych, W.C.2. Both are based on the same main body of sheet steel, stove enamelled white, with a central housing for control gear, and are available in single or twin lamp patterns. The F1206 has rectangular metal louvres, double spaced at each end to shield the lampholders from view. The F1207 is provided with an opal "Perspex" diffuser tray which is divided into five sections by transverse ribs.

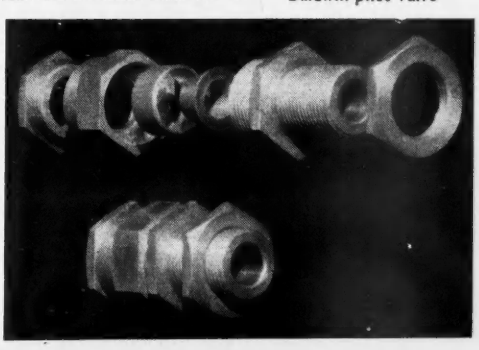


*B.T.H. "Mazda" F1206 recessed fluorescent fitting*

The fittings can be recessed into ceilings between joists or suspended on rods to fit flush with a secondary ceiling. Both the louvred panel and the "Perspex" diffuser tray rest on the inner edge of the fitting at each end and are easily removed for cleaning and maintenance.

### Electro-Magnetic Pilot Valve

The BALDWIN INSTRUMENT CO., LTD., Brooklands Works, Dartford, Kent, has developed a new electro-magnetic pilot valve for use with pneumatic equipment. It is of the glandless poppet type, employing a new type of actuator of advanced design and performance. The development of an efficient magnetic circuit combined with optimum coil design has resulted in a compact and powerful unit capable of handling fluids at higher pressures and flow rates than has previously been possible. Two models are at present available with slightly different valve mechanisms and both may be used for vacuum service if required. All models operate on d.c., a metal rectifier being supplied as a separate unit for use when working from a.c.



*Baldwin pilot valve*

## *Financial Section*

# STOCKS and SHARES

THE tenor of the review given by Lord Chandos at the annual meeting of Associated Electrical Industries had a tonic effect upon the market in electrical engineering shares, and no doubt contributed to the appearance of an improved complexion upon the industrial market as a whole. Other helpful factors included the increase reported in the country's gold and dollar reserves in March and some more good company results such as those from C. A. Parsons. Checks to the general recovery of prices seemed to be associated more with foreign affairs than with apprehension about next Tuesday's Budget.

### A.E.I. New Shares

Associated Electrical Industries £1 shares went further ahead to 68s (the official quotation lagged behind the market price) on the strength of the chairman's review of the group's results and prospects. The premium on the new £1 shares issued at 57s 6d, and now 20s paid, widened to 9s 3d, a very satisfactory figure for the stockholders who decided to take up their allotments when it stood at no more than a few pence. These new shares are not entitled to the first two interim payments for the current year. Allowing for this, however, and, on the other hand, for the fact that they are transferable free of stamp, it is to be noted that at their all-in current price of 66s 9d they are a materially cheaper purchase than the old shares, for the investor prepared to forgo a dividend return until later this year. The yield on them from a full year's dividend at 15 per cent is 4½ per cent.

### Financing Expansion

With the £25 million capital issue successfully completed, Lord Chandos had much of general interest to say, at last week's A.E.I. meeting, about the financing of the further great expansion plans to which the group is committed in order to keep abreast of the continuously growing demand for electrical plant. In his opinion, large industrial concerns are going to find their financial needs to be beyond the capacity of the market to supply them, and will therefore rely increasingly for the purpose upon retained profits. A.E.I. policy aims at the maintenance or enlargement of profits by increased turnover and efficiency, so as to hold out the hope of increases in dividends and thus of a profitable investment, while retaining earnings on, at least, the present scale as the main source of finance for the growth of the enterprise. In raising the dividend from 14 to 15 per cent, A.E.I. are distributing £2·2 million of the 1955 net profit, of which £8·4 million goes back into the business.

### Price Recovery

Recoveries of around 5s each in English Electrics and G.E.C. are

## *Price Changes in*

| Company or Board | Nom. Value | Middle price 9th Apr. | Three Weeks' Rise or Fall | Dividend Previous | Dividend Last | Yield % | 1955 Highest | 1955 Lowest |
|---|---|---|---|---|---|---|---|---|
| *Gilt-edged Stocks* | | | | | | £ s d | | |
| Brit. Elec. 1968/73 | 100 | 76½ | +½ | 3 | 3 | 3 18 6 | 94⅜ | 76½ |
| Brit. Elec. 1974/77 | 100 | 74½ | | 3 | 3 | 4 0 6 | 93⅛ | 75½ |
| Brit. Elec. 1976/79 | 100 | 80½ | +½ | 3½ | 3½ | 4 7 3 | 98⅜ | 80½ |
| Brit. Elec. 1974/79 | 100 | 88½ | −¼ | 4¼ | 4¼ | 4 15 6 | 109 | 90½ |
| *Overseas Electric Supply* | | | | | | | | |
| Calcutta Elec. | £1 | 19/9 | +6d | 6† | 6† | 6 1 6† | 22/6 | 20/9 |
| East African Power | £1 | 21/- | | 7 | 7 | 6 13 3 | 24/6 | 19/9 |
| Nigerian Elec. | £1 | 20/3 | +6d | 10 | 10 | 9 17 6 | 27/- | 21/- |
| Palestine Elec. "A" | £1 | 21/- | | Nil | Nil | Nil | 22/9 | 21/- |
| Perak Hydro-Elec. | £1 | 16/- | +1/- | 10 | 10 | — | 22/3 | 17/9 |
| *Equipment and Manufacturing* | | | | | | | | |
| Aberdare Cables | 5/- | 12/- | +1/- | 12½ | 17½ | 7 5 9 | 14/6 | 11/- |
| Aerialite | 1/- | 5/3 | | 88⅛ | 45* | 8 11 6 | 6/9 | 5/3 |
| Allen, W. H. | £1 | 68/- | +1/- | 20 | 20 | 5 17 9 | 83/9 | 74/6 |
| Aron Elec. Ord. | £1 | 54/3 | | 15 | 15 | 5 10 6 | 63/9 | 55/6 |
| Assd. Automation | 10/- | 26/- | −2/- | 10 | 10 | 3 17 0 | 32/- | 11/- |
| Assoc. Elec. Ord. | £1 | 66/3 | +6/9 | 14 | 15 | 4 10 6 | 96/- | 62/6 |
| Automatic Tel. & El. | £1 | 62/6 | +1/3 | 15 | 15* | 4 16 0 | 79/6 | 60/- |
| Babcock & Wilcox | £1 | 74/6 | +4/6 | 12* | 15 | 4 0 6 | 98/- | 68/6 |
| Baldwin, H. | 2/- | 4/3 | +3d | 20 | 20 | 9 8 6 | 5/6 | 4/4 |
| Bakelite | 10/- | 26/6x.d. | | 16 | 16 | 6 0 9 | 34/6 | 27/- |
| Berry's Electric | 5/- | 6/- | +3d | — | 10‡ | 8 6 8 | — | — |
| British Aluminium | £1 | 52/-x.d. | +7/9 | 12 | 12 | 4 12 3 | 58/- | 35/3 |
| B.I. Callender's | £1 | 50/6 | +1/- | 10 | 12½‡ | 4 19 0 | 55/3 | 44/9 |
| B.I. Callender's 6% Pref. | £1 | 22/- | | 6 | 6 | 5 9 0 | 26/6 | 21/9 |
| British Thermostat | 5/- | 25/6 | | 27½ | 27½ | 5 7 9 | 35/- | 22/6 |
| British Vac. Cleaner | 5/- | 7/- | | 30 | 15* | 10 14 6 | 10/- | 6/6 |
| Brook Motors | 10/- | 40/- | | 20 | 25 | 6 5 0 | 47/- | 39/9 |
| Brush Ord. | 5/- | 7/- | +6d | 6 | 10 | 7 2 9 | 9/6 | 7/6 |
| Bulgin, A. F. | 1/- | 7/- | −3d | 45 | 50 | 7 2 9 | 8/- | 4/- |
| Burco Dean | 5/- | 8/9 | −3d | — | 22½ | 12 17 0 | 17/3 | 12/- |
| Chloride El. Storage "A" | £1 | 65/6 | +1/6 | 12½ | 17½ | 5 6 9 | 77/6 | 58/6 |
| Clarke Chapman | £1 | 93/9 | +1/9 | 20 | 22½ | 4 16 0 | 102/6 | 68/9 |
| Cole, E. K. | 5/- | 16/9 | −9d | 27½ | 17½* | 5 4 6 | 25/6 | 18/3 |
| Cossor, A. C. | 5/- | 7/3 | +3d | 10 | 15 | 10 6 9 | 14/- | 8/9 |
| Crabtree | 10/- | 28/6 | +6d | 20 | 20 | 7 0 3 | 34/6 | 27/6 |
| Crompton Parkinson Ord. | 5/- | 14/9 | +1/9 | 20 | 16* | 5 8 6 | 19/9 | 15/- |
| De La Rue | 5/- | 19/6 | +2/6 | 20 | 30 | 7 13 9 | 26/- | 17/- |
| Decca | 4/- | 29/- | | 56¼ | 43¾* | 6 0 9 | 48/9 | 31/- |
| Desoutter | 5/- | 26/6 | | 25 | 30 | 5 13 3 | 35/- | 25/6 |
| Dewhurst | 2/- | 11/- | +3d | 24 | 30 | 5 9 0 | 11/3 | 7/3 |
| Dictograph Tel. | 2/- | 6/3 | +3d | 20 | 20 | 6 8 0 | 9/3 | 9/6 |
| Dubilier Condenser | 1/- | 4/3 | +3d | 25 | 25* | 5 17 9 | 5/7 | 3/1 |
| E.M.I. | 10/- | 29/6 | +1/6 | 10 | 15 | 5 1 9 | 37/- | 25/3 |
| Electrical Components | 5/- | 13/9 | | 20 | 25 | 9 1 9 | 21/3 | 13/9 |
| Elec. Construction | £1 | 27/3 | | 15 | 8⅓ | 6 4 6 | 41/3 | 28/9 |
| Enfield Cable Ord. | £1 | 17/- | +1/9 | Nil | Nil | Nil | 25/3 | 18/6 |
| English Electric | £1 | 57/6 | +5/9 | 12½ | 12½ | 4 7 0 | 86/9 | 54/3 |
| English Electric 3½% Pref. | £1 | 13/3 | | 3½ | 3½ | 5 13 3 | 16/9 | 14/- |
| Ericsson Tel. | 5/- | 38/- | +3/- | 25† | 25*† | 3 5 9† | 46/6 | 29/- |
| Ever Ready | 5/- | 27/6 | +1/6 | 40 | 35* | 6 7 3 | 38/- | 2/3 |
| Falk Stadelmann | £1 | 38/- | | 15 | 17½ | 9 4 3 | 52/6 | 42/- |
| G.E.C. Ord. | £1 | 57/6 | +4/6 | 12½ | 14 | 4 17 3 | 80/3 | 51/3 |
| G.E.C. 6½% Pref. | £1 | 22/9 | | 6½ | 6½ | 5 14 3 | 28/4 | 23/6 |
| General Cables | 5/- | 13/- | | 30 | 30 | 11 10 9 | 17/- | 15/- |
| Greenwood & Batley | £1 | 46/3 | | 17½ | 17½ | 7 11 3 | 57/6 | 45/- |
| Hackbridge Cable | 5/- | 22/9 | +2/9 | 20 | 25 | 5 10 0 | 23/9 | 14/- |
| Hackbridge & Hewittic | 5/- | 17/9 | | 25 | 30 | — | 24/9 | 17/- |
| Heatrae | 2/- | 4/9 | | 12½ | 15 | 6 6 3 | 5/9 | 4/3 |
| Henley's | 10/- | 16/- | +1/- | 10½ | 10½ | 6 11 3 | 21/3 | 15/9 |
| Holophane | 5/- | 17/6 | | 25 | 30 | 8 11 6 | 19/9 | 16/- |

The above quotations are based upon middle prices in the Stock Exchange Daily Official List.
* After scrip issue. † Free of income tax. ‡ Dividend forecast.

among the best of the many improvements shown in the accompanying lists, which cover changes during the three weeks since before the Easter holiday. Ericssons rose by 3s, Cromptons put on 1s 9d and Plesseys were as much as 8s 3d to the good. Parsons and Reyrolles reflect the excellent results published by those companies with gains of 9s and 6s 6d respectively at the beginning of this week. The rise of 7s 9d in British Aluminiums was also a reaction to good annual figures. Babcocks remained well supported, and, in anticipation of dividends and results due this month, the cable group was notably firm, with rises of 1s or more in British Insulated Callenders, Aberdare Cables, Henley's and Telegraph Construction & Maintenance, and of 2s 9d in Hackbridge Cable.

# *Electrical Investments*

| Company or Board | Nom. Value | Middle price 9th Apr. | Three Weeks' Rise or Fall | Dividend Previous | Dividend Last | Yield % | 1955 Highest | 1955 Lowest |
|---|---|---|---|---|---|---|---|---|
| *Equipment and Manufacturing—continued* | | | | | | £ s d | | |
| Hoover | 5/- | 26/- | +2/- | 70 | 50 | 9 12 3 | 52/6 | 35/6 |
| I.C.I. | £1 | 45/3 | +6d | 15 | 10* | 4 8 6 | 61/9 | 38/3 |
| Intl. Combustion | 5/- | 19/- | +1/- | 25 | 20* | 5 5 3 | 24/6 | 16/- |
| Johnson & Phillips | £1 | 38/9 | | 15 | 15 | 7 14 9 | 52/6 | 39/6 |
| Lancashire Dynamo | £1 | 42/- | | 14 | 15 | — | 56/5 | 37/3 |
| Laurence, Scott | 5/- | 13/9 | −3d | 20 | 12½* | 4 11 0 | 19/6 | 14/6 |
| Lister, R. A. | £1 | 28/9 | +3d | 9·3 | 10 | 6 19 3 | 40/- | 28/9 |
| London Elec. Wire | £1 | 51/9 | +2/3 | 10 | 12½ | 4 16 6 | 61/3 | 50/6 |
| Lucas, J. | £1 | 33/6 | +6d | 7½ | 7½ | 4 9 6 | 56/6 | 38/9 |
| Marryat & Scott | 2/- | 9/3 | | 25 | 30 | 6 9 9 | 13/- | 9/6 |
| Mather & Platt | £1 | 55/6 | +2/6 | 13·4* | 15 | 5 8 0 | 75/- | 48/- |
| Metal Industries | £1 | 17/- | | 9 | 9 | — | 38/- | 25/- |
| Midland Elec. Mfg. | £1 | 43/6 | | 10 | 12½ | 5 15 0 | 55/- | 44/- |
| Morphy-Richards | 4/- | 22/6 | +3d | 35 | 50 | 8 17 9 | 35/- | 27/- |
| Murex | £1 | 63/3 | +6d | 15 | 20 | 6 6 6 | 67/6 | 49/3 |
| Newman Ind. | 2/- | 2/6 | | 10 | 10 | 8 0 0 | 3/6 | 2/4 |
| Oldham & Son | 1/- | 2/6 | | 17½ | 20 | — | 3/6 | 2/1 |
| Parnall (Yate) | 5/- | 7/- | +6d | 8 | 14 | 10 0 0 | 13/2 | 7/3 |
| Parsons, C. A. | £1 | 80/- | +9/- | 10 | 10 | 2 10 0 | 100/- | 56/- |
| Plessey | 10/- | 71/3 | +8/3 | 27½ | 30† | 4 4 3 | 89/- | 55/- |
| Pye "A" Deferred | 5/- | 15/9 | +1/3 | 20 | 12½* | 3 19 3 | 32/9 | 14/3 |
| Revo | 10/- | 10/6 | +1/3 | 9 | 9 | 8 11 6 | 15/6 | 12/6 |
| Reyrolle | £1 | 97/6 | +6/6 | 15 | 16½ | 3 6 9 | 127/6 | 89/- |
| Rheostatic | 4/- | 13/- | +6d | 22½ | 18½* | — | 14/3 | 9/3 |
| Richardsons Westgarth | 5/- | 14/6 | | 15 | 16⅔ | 5 15 0 | 19/- | 11/- |
| Scottish Cables | 4/- | 16/3 | | 27½ | 27½ | 6 15 3 | 22/6 | 16/3 |
| Smith (England), S. | 4/- | 12/9 | +9d | 17½ | 17½ | 5 9 9 | 20/- | 14/9 |
| Southern Areas | £1 | 22/6 | −2/- | 7½ | 10 | 8 17 9 | 38/- | 27/6 |
| Strand Elec. | 5/- | 7/6 | +3d | 17½ | 15* | 10 0 0 | 13/3 | 7/6 |
| Sturtevant | 5/- | 26/- | +6d | 18·9 | 14·4*† | 2 15 9† | 35/9 | 21/- |
| Sun Elec. | £1 | 36/- | | 15 | 20 | 11 2 3 | 35/- | 33/9 |
| Switchgear & Cowans | 5/- | 14/6x.d. | | 20 | 25 | 8 12 6 | 17/- | 11/- |
| Taylor Tunnicliff | 5/- | 11/3 | +3d | 15 | 15 | 6 13 3 | 16/3 | 11/3 |
| T.C.C. | 10/- | 40/-x.d. | | 25 | 25 | 6 5 0 | 53/9 | 41/- |
| T.C. & M. | £1 | 29/6 | +1/6 | 8½ | 8½ | 5 15 3 | 40/9 | 29/3 |
| Telephone Mfg. | 5/- | 6/9 | | 10 | 10 | 7 8 3 | 11/6 | 7/9 |
| Thorn Elec. | 5/- | 18/- | | 20 | 15* | 4 3 6 | 33/- | 13/9 |
| Thornycroft | £1 | 42/6 | −1/- | 15 | 15* | 7 1 3 | 48/9 | 34/6 |
| Tube Investments | £1 | 60/- | +1/- | 22½ | 14*† | 4 13 3 | 62/6 | 55/- |
| Vactric | 5/- | 12/6x.c. | | 10 | 15* | — | — | — |
| Veritys | 5/- | 6/9 | | 12½ | 12½ | 9 5 3 | 12/2 | 7/- |
| Walsall Conduits | 4/- | 11/9 | +9d | 70 | 70 | — | 17/3 | 12/- |
| Ward & Goldstone | 5/- | 32/- | | 50 | 30* | 4 13 9 | 45/- | 32/6 |
| Watford | 2/- | 6/9 | | 22½ | 25 | — | 8/9 | 6/3 |
| Westinghouse Brake | £1 | 77/6 | +2/- | 18 | 18 | 4 12 9 | 110/- | 82/- |
| West, Allen | 5/- | 13/3 | +9d | 17½ | 15* | 5 13 3 | 16/6 | 8/- |
| Wolf Electric | 5/- | 19/6 | −6d | 20 | 20 | 5 2 6 | 26/3 | 16/1 |
| *Trusts, Transport and Communications* | | | | | | | | |
| Anglo-Am. Tel.: | | | | | | | | |
| A. Ord. | 100 | 75 | | 6 | 6 | 8 0 0 | 88 | 67½ |
| Ord. | 100 | 49 | | 3¾ | 3¾ | 7 13 0 | 54½ | 45 |
| Anglo-Portuguese | £1 | 21/3 | +3d | 8 | 8 | 7 10 6 | 27/- | 21/- |
| Brit. Elec. Traction: | | | | | | | | |
| Def. Ord. "A" | 5/- | 17/6 | | 50 | 22½* | 6 8 6 | 24/3 | 19/- |
| Cable & Wireless: | | | | | | | | |
| Ord. | 5/- | 10/6 | | 10 | 10 | 4 15 3 | 13/6 | 10/- |
| 4% Loan | 100 | 91 | | 4 | 4 | 4 8 0 | 100 | 92/- |
| Calcutta Trams | £1 | 23/6 | −9d | 6† | 7½† | 6 7 9† | 26/9 | 20/- |
| Cape Elec. Trams | £1 | 18/9 | −1/3 | 5½ | 7½ | 8 0 0 | 19/6 | 16/6 |
| Marconi Marine | £1 | 31/6 | | 10 | 10 | 6 7 0 | 41/3 | 31/3 |
| Oriental Tel. Ord. | 1/- | 83/- | | 16 | — | — | 102/6 | 72/6 |
| Telephone Rentals | 5/- | 10/3 | | 10 | 12½ | 6 2 0 | 13/6 | 9/6 |

## C. A. Parsons Earnings

In the matter of financing expansion out of retained profits, few companies can match the scale upon which this is practised by C. A. Parsons. With the profits of 1955 up by the best part of half a million to nearly £2 million, this company is paying the same rate of dividend as before, namely 10 per cent for the year, which costs little more than £200,000, or less than one-ninth of the amount available. In the previous year, about seven-eighths of the profit went back into reserves. Stockholders were told then that the implementation of the expansion planned would mean a conservative financial policy for several years, so that this year's dividend decision came as no disappointment. Satisfaction with the results was expressed in the further rise of 9s, to 80s, in the price of the £1 shares.

## Murphy Results

Murphy Radio 5s shares, having been depressed recently by events affecting the radio industry as a whole, recovered from 11s 9d to 12s 9d in response to the good figures disclosed in the preliminary profits statement for 1955. The dividend is being kept at the 20 per cent rate to which it was increased twelve months ago, but it applies to capital substantially increased by last year's rights issue of new ordinary capital, bringing the latter up to £910,000. The amount of the distribution remains covered twice over by available earnings, the net profit being some 30 per cent higher than before at £244,000, after a larger tax charge. The yield on the shares now works out at approximately 7·8 per cent.

## Dividends and Wages

At this season of company results and distributions, special interest is attached to those sections of the recently issued White Paper on full employment which deal with dividends. They show that between 1938 and 1948 dividend distributions rose by 10 per cent, while wages and salaries put on 117 per cent; so that although in the subsequent period up to last year both rose together by a further 63 per cent, the calculation is that, over the whole period 1938–1945, an improvement of 40 per cent in the real value of wages and salaries compares with a decrease of 30 per cent in that of dividends. The latter, in sum, account for 5 per cent of total incomes in the country, while wages and salaries make up 60 per cent of it; and last year they involved the distribution of little more than one-fifth of total company incomes.

# REPORTS and DIVIDENDS

**Associated Electrical Industries, Ltd.**—The annual meeting was held on 4th April, Viscount Chandos (chairman) presiding. Reviewing the activities of the group during the past year, Lord Chandos said that over 1,400 MW of major generating plant was commissioned of which fifty-five machines totalling some 900 MW were installed overseas.

Notable among the hydro-electric work undertaken were the Los Peares power station, equipped by the British Thomson-Houston Co., Ltd., and the San Esteban station, equipped by the Metropolitan-Vickers Electrical Co., Ltd. The first two M-V generators for the Bersimis station in Canada, which would be the most powerful of their kind in the world, were now being installed. Steam driven generators included a 66 MW machine shipped by M-V to Canada, which would be the largest 3,600 r.p.m. set in that country, and the B.T.H. single cylinder 30 MW set for Wallerawang in Australia, which was awaiting dispatch at the end of the year.

There had been record shipments of switchgear, transformers and cables. Amongst these were five 120 MVA transformers for the C.E.A. supplied by M-V. At West Melton, the B.T.H. Co. erected the 275 kV switching station for the C.E.A. Ferguson, Pailin shipped a large order of fifty ring main units to Egypt for the Cairo Electricity and Gas Administration. The output of Birlec, the recently acquired subsidiary, included a mains frequency furnace which was the first to be manufactured in England, as well as an installation for heating aluminium billets in a low frequency furnace which again was the first of its kind.

Outstanding achievements of the B.T.H. Co. were the commissioning of a 1,000 kW germanium power rectifier for electrolytic service and the shipping of the first of ten 4,050 kW mechanical rectifiers, which were the first of their kind in the British Isles. The Metropolitan-Vickers Co. had nearly completed the shipment of the large order for locomotives for the Western Australian Government, and deliveries of ninety-four locomotives for Eire were also far advanced. The electronic business continued to grow rapidly.

Siemens Brothers had completed major contracts for telephone equipment, both for the G.P.O. and overseas authorities; they had built the first semi-automatic trunk exchange with a cordless switchboard in this country. An outstanding achievement had been the laying of the first part of the trans-atlantic telephone cable. This was supplied by Submarine Cables, Ltd., in which company Siemens Brothers held a half interest. The second part of the cable was now being manufactured.

Lord Chandos referred to the agreement with the Indian Government under which the A.E.I. had been appointed consultants for fifteen years for the building of large works to manufacture heavy electrical equipment.

Regarding the future, at the close of 1955 they had firm orders in hand to the value of £150 million, and orders received during the year were £141 million. These included orders for forty-four turbo-generators received by M-V for home and overseas with an aggregate capacity of 1¼ million kW; nearly half of this was for the C.E.A. These orders brought the total number of machines of 100 MW capacity and over under construction by M-V for the C.E.A. to twelve. Outstanding orders received by the B.T.H. Co. included one for seventy-eight pumpless steel tank mercury arc rectifiers for plant producing aluminium in the French Cameroons, and another for germanium rectifiers totalling 8,000 A at 230 V for a large chemical works in this country. Orders placed by the British Railways with A.E.I. companies included thirty diesel-electric locomotives, as well as twenty power equipments for installation in locomotives to be built by British Railways themselves.

Two orders received by M-V from the Atomic Energy Authority were for a 50 million V proton accelerator and a 25 million V linear accelerator with a mean beam power of 30 kW which would be the most powerful tool at this energy level in the world. Another 50 MeV proton accelerator was under construction for the European Council for Nuclear Research in Geneva. Orders in hand by Siemens included the complete installation at the Cairo International Radio Centre.

Referring to the new holding company in Australia, A.E.I., Ltd., formed to acquire the assets and undertakings of the former A.G.E., renamed Australian Electrical Industries Pty., Ltd., Viscount Chandos said that that company had a considerable expansion programme in hand at a cost of about £A2 million. Changes in the organisation of the group included combining the Siemens and Ediswan Companies into a new company called Siemens-Ediswan. The A.E.I. Lamp & Lighting Co., the formation of which was referred to last year, had now become a fully operational company in the B.T.H. group.

Lord Chandos then referred to the continued expansion of the electrical industry, the construction of nuclear power stations, the future growth of diesel-electric and electric traction, and the increasing uses of electronic apparatus, particularly in the field of semi-conductors. It was against this background that the group was engaged on a large expansion programme of the various works, some projects of which were far advanced and others either recently begun or only in the planning stage. He also spoke of the plans for increasing the facilities for research and education. These plans for the future involved large sums and in making the recent rights issue of 8,500,000 shares at 57s 6d each, the directors felt it necessary to anticipate the ordinary programme of finance for the company, because of the uncertain outlook for credit, and the greatly curtailed lending powers of the banks.

Speaking of profits and profit margins, the chairman said that the general trend in the electrical industry was towards higher turnover and narrower profit margins, which was healthy. The legal or artificial limitation of dividends was wholly unsound, but, on the other hand, up-to-the-hilt distributions were against the interests of the nation and of industry. He concluded his address by reviewing the main figures in the accounts.

**The Telephone & General Trust, Ltd.**—The annual meeting will be held on 24th April. In his circulated statement, Sir Alexander Roger (chairman and managing director) says that in spite of the year by year increase in the number of telephones installed in Portugal by the Anglo-Portuguese Telephone Co., in which the Trust holds a substantial investment, there is no apparent slackening in demand and further expansion of telecommunications is likely with the broadening and increasing industrial development of the country.

In the West Indies, the telephone operating companies in which the Trust is interested in Jamaica, Trinidad and Tobago, and Barbados continued with their policy of expanding and improving the telephone services in their respective territories.

**Ericsson Telephones, Ltd.**—In the course of his speech at the annual meeting held on 29th March, Sir Harold Wernher (chairman) said that the past year had established three records—the biggest order book, highest production and greatest labour force. The slight fall in trading profit was mainly due to keener competition for overseas business and the increased labour costs following the wage award granted in April last. These recurring demands for increases were disturbing, particularly to those concerns engaged in export trade. Approximately half the company's orders for 1955 were received from overseas customers, and home sales had also shown a marked improvement. The long-term programme of the Post Office included the replacement of the remaining manual by automatic exchanges, the development of subscribers' trunk dialling and work on the application of electronic techniques. The proposals of the P.M.G., as announced in the House of Commons, included a return to something approaching the pre-war relations with the Treasury, which

(*Continued on page* 593)

## FINANCIAL SECTION (*continued*)

meant that instead of the whole P.O. annual surplus being paid over to the Treasury, there would be a standing payment of £5 million per annum, the surplus being used to expand and improve the service. The telephone industry of the country would be quite capable of handling this expanded programme. Sir Harold referred to the shortage of trained and qualified engineers and technicians and the company's continued expansion in the field of research and development.

**C. A. Parsons & Co., Ltd.,** report a substantial increase in profits for 1955. After providing for taxation of £1,718,400 and contingencies provision of £115,000, the year's net profits are £1,962,613, as compared with £1,484,298 for 1954. It is proposed to maintain the dividend for the year at 10 per cent with a final payment of 6¼ per cent. Sir Claude Gibb (chairman), at last year's annual meeting, said that if the directors' plans for major expansion of works became possible of implementation it would be necessary to conserve finances for several years ahead and a standstill in dividend payments might become essential.

**A. Reyrolle & Co., Ltd.**—The net profit for 1955 is £1,986,296, as compared with £1,647,017 for the preceding year. This includes a surplus of £232,372 arising from the revision of the basis of valuation of work in progress requested by the Inland Revenue, and is struck after taxation of £1,690,587. It is proposed to pay a final dividend of 10 per cent (against 8¾ per cent) making 16¼ per cent for the year (against 15 per cent).

**Enfield Rolling Mills, Ltd.**—The group trading profit for 1955 is £2,139,522, as compared with £1,384,277 for 1954, and after deducting £876,000 for taxation, £43,955 issue expenses, and £25,095 staff pensions, the net balance is £938,465 (against £616,873). Reserves receive £770,000 and it is proposed to pay a final dividend of 17½ per cent on ordinary capital of £1,555,000. With the interim dividend of 5 per cent on £1,425,000, the total distribution for the year is 22½ per cent. This compares with 20 per cent for 1954 on £1,008,000 capital before the issue of £6,000 ordinary shares against an acquisition and a two-for-five rights offer. The balance carried forward is £118,345 (against £226,608 brought in).

**Bylock Electric, Ltd.**—An extraordinary meeting was held on 5th April at which resolutions were passed increasing the issue capital to £90,000 by the issue to each shareholder of one new "A" non-voting ordinary share credited as fully paid for each existing ordinary share held.

At the annual meeting which followed, Mr. A. C. Mathes (chairman), said that it was contemplated that the restrictions upon hire purchase, which had arisen since October last, would have an adverse effect upon home sales, but up to date, whilst they had found some resistance, the home sales turnover had not suffered to anything like the extent they contemplated. The export position had been maintained, and from present indications, they hoped to be able to keep fully abreast with the competition which was arising on all hands, and to finish the current year with a turnover which would compare favourably with that of last year, when they had not the same restrictions. They had developed and were shortly putting on the market, an improved hair dryer which they were confident would meet competition both as to efficiency and price in the home and overseas markets.

**Parkinson & Cowan, Ltd.**—The consolidated gross trading profit for 1955 amounts to £218,877, as compared with £383,167 for 1954, and the net result for the year is a loss of £35,456 (against a profit of £123,821). The fixed assets replacement reserve of £50,000 has been credited to the profit and loss account to offset the depreciation and exceptional obsolescence of certain fixed assets during the year and this, together with a credit of £7,178 for adjustments relating to previous years, leaves a consolidated surplus of £21,722 (£123,919). It is proposed to pay an ordinary dividend for the year of 5 per cent (against 9 per cent).

**Blaw Knox, Ltd.**—The accounts for 1955 show a trading profit of £388,089, as compared with £394,128 for the preceding year, and after meeting all charges, including £164,243 for taxation, the net profit is £171,122 (against £185,319). General reserve receives £100,000 and it is proposed to pay a final dividend of 20 per cent, making 30 per cent for the year. This is at the same rate as for 1954 but is paid on larger capital. The balance carried forward is £282,333 (against £319,990 brought in).

**Murphy Radio, Ltd.,** reports a consolidated profit for 1955 of £502,421, as compared with £410,281 for 1954, and after deducting £275,190 for taxation and adding taxation adjustments in respect of earlier years of £17,144, the net balance is £244,375 (against £185,123). The ordinary dividend for the year is maintained at 20 per cent on increased capital. The balance carried forward is £246,656 (against £130,987 brought in).

**Joseph Lucas (Industries), Ltd.,** is doubling its interim ordinary dividend to 2½ per cent in order to reduce the disparity between the interim and final dividends. It is emphasised that this increase will have no influence on the total dividend for the year.

**The Oriental Telephone & Electric Co., Ltd.,** is paying a dividend of 320 per cent on capital of £28,510. For 1954, the interim dividend was 4 per cent on £570,199 capital, and was followed by a capital repayment of 19s per £1 unit, a second interim of 240 per cent and a final of 180 per cent. The group profits were £26,774, as compared with £183,601, after meeting all charges, including £50,528 for taxation.

**The Perak River Hydro-Electric Power Co., Ltd.,** has declared an interim dividend of 4 per cent (against nil) on larger capital. For the previous year the total distribution was 10 per cent.

**Brook Motors, Ltd.,** has declared an interim dividend of 5 per cent (unchanged).

**J. & F. Stone Lighting & Radio, Ltd.,** is paying an interim dividend of 10 per cent (unchanged).

### Increases of Capital

**Beaufort Electrical Engineering Co., Ltd.** (formerly Beaufort Electrical & Radio Service, Ltd.).—Increased by £8,000, in £1 6½ per cent redeemable preference shares, beyond the registered capital of £5,000.

**R. D. H. Thompson & Co., Ltd.**—Increased by £2,000 in £1 ordinary shares, beyond the registered capital of £3,000.

**Bescol (Electric), Ltd.**—Increased by £9,000, in £1 ordinary shares, beyond the registered capital of £1,000.

### Bankruptcies

**V. F. Pitt,** electrical engineer, carrying on business at 54, Mortimer Street, Herne Bay.—Receiving order made 21st March on debtor's own petition. Public examination 15th May at the Sessions House, Longport, Canterbury.

**F. E. V. Hooper,** lately residing and carrying on business at 277, South Road, Walkley, Sheffield, also carrying on business as Hoopers Service Station at Walkley Road, Walkley, Sheffield, electrical engineer.—Application for discharge to be heard on 26th April at the County Court Hall, Bank Street, Sheffield.

**C. R. Boydon,** residing and carrying on business at Ivy House, Thorpe Mandeville, near Banbury, Oxon, and lately carrying on business at 19a, Castle Street West, Banbury, electrical engineer.—Application for discharge to be heard on 11th May at the Town Hall, Banbury.

**H. J. Couzens,** Canton Works, 165, Young Street, Sheffield, electrical contractor.—Supplemental dividend of 1s in the £, payable at the Official Receiver's office, 55, Queen Street, Sheffield.

### Liquidations

**W. D. Foster (London), Ltd.,** electrical engineers.—Winding up voluntarily. Liquidator, Mr. J. R. Ingoldby, 71, Calton Avenue, Dulwich Village, S.E.21, appointed 14th March.

**E. H. Maw, Ltd.,** electricians and radio dealers.—Winding up. Liquidator, Mr. R. W. Hellyer, 3, Eldon Place, Bradford, appointed 16th March.

# NEW PATENTS

## Electrical Specifications Recently Published

*The numbers under which the specifications will be printed and abridged are given in parentheses. Copies of any specification (3s 0d each including postage) will be obtainable after 18th April from the Patent Office, 25, Southampton Buildings, London, W.C.2.*

**1950**

23877. Standard Telephones & Cables, Ltd.—Electrical information storage circuits. 29th September, 1950. (747811.)

29921. National Research Development Corporation.—Electric signalling. 5th December, 1951. (747851.)

**1951**

708. Standard Telephones & Cables, Ltd. —Electrical communication system. 10th January, 1951. (748072.) 18187. Information storage circuits. 25th July, 1952. (748012.)

25112. Brennan, J. B.—Electrodes for electrolytic devices. 26th October, 1951. (747962.)

**1952**

14370. Hohner Akt.-Ges., M.—Electrical musical instruments. 6th June, 1952. (747963.)

17575. General Electric Co., Ltd., Foxon, H. J., and Sowter, A. B.—Pressure welding. 3rd July, 1953. (748015.)

18083. Sheldon, E. E.—Electric discharge vacuum tubes. 17th July, 1952. (747855.)

22529. Metropolitan-Vickers Electrical Co., Ltd.—Cam actuated linkages. 8th September, 1953. (747823.)

25437. Standard Telephones & Cables, Ltd.—Electron gun. 10th October, 1952. (747858.)

29863. Etablissements E. Jaeger.—Electric thermometers. 25th November, 1952. (747828.)

30090. British Thomson-Houston Co., Ltd.—Methods of stabilisation of speed controlled d.c. motors. 27th November, 1953. (748019.)

**1953**

4640. Electric & Musical Industries, Ltd. —Electrical pulse generator chain circuits and gating circuits embodying such chain circuits. 2nd February, 1954. (747863.)

12886. English Electric Co., Ltd.—Automatic voltage regulating systems for alternators. 7th May, 1954. (747867.)

12951. Compagnie Générale de Télégraphie sans Fil.—Storage type cathode-ray tubes. 8th May, 1953. (747868.)

16113. General Electric Co.—Methods of electroplating aluminium. 11th June, 1953. (747871.)

16372. Spragg, W. H.—Apparatus for indicating the settings of tone controls, frequency equalisers, filters or the like devices, associated with electronic apparatus. 10th June, 1954. (748089.)

16697. Rotax, Ltd.—Means for controlling associated a.c. generators. 4th June, 1954. (748036.)

19696. Hughes Aircraft Co.—Electron space charge wave amplifier tube. 15th July, 1953. (747904.)

21535. Metropolitan-Vickers Electrical Co., Ltd.—Air or gas blast electric circuit-breakers. 4th August, 1954. (748038.)

23049. Marsden & Bateson, Ltd.—Method of and means for fixing inset electric fires in their surrounds. 23th August, 1954. (748040.)

23809. Standard Telephones & Cables, Ltd. (International Standard Electric Corporation).—Magnetron strapping arrangement. 28th August, 1953. (747912.)

25995. Standard Telephones & Cables, Ltd.—Electromagnetic relays. 17th September, 1954. (747915.)

28006. General Electric Co., Ltd., and Paterson, K. G.—Electric filter circuits. 8th November, 1954. (748044.)

28351. British Thomson-Houston Co., Ltd.—Multi-cavity magnetrons. 18th October, 1954. (747917.)

30657. Lorant, H. J.—Mounting means for electric motors and other heavy devices. 4th November, 1954. (748101.)

31308. Lincoln Electric Co.—Fusion welding. 11th November, 1953. (747920.)

32261. Cass, E. R.—Electric polishing machines for floors and the like. 20th December, 1954. (748107.)

33812. British Thomson-Houston Co., Ltd.—Electric discharge devices. 2nd December, 1954. (747923.)

35179. General Electric Co., Ltd., and London, C. A.—Electric contact arrangements. 29th November, 1954. (747925.)

35740. Union Carbide & Carbon Corporation.—Electric dry cells. 23rd December, 1953. (747844.)

35754. Philips Electrical Industries, Ltd. —Mass spectrometers. 23rd December, 1953. (747977.)

**1954**

593. Marconi's Wireless Telegraph Co., Ltd.—Radar systems. 25th November, 1954. (748110.)

2505. Philips Electrical Industries, Ltd.— Inductance coils. 27th January, 1954. (747875.)

2768. Philips Electrical Industries, Ltd.— Circuits supplying electro-luminescent lighting panels. 29th January, 1954. (747877.)

3329. English Electric Co., Ltd.—Construction of end caps for electrical bushings. 4th February, 1955. (747880.)

3960. Marconi's Wireless Telegraph Co., Ltd.—Radio direction finders. 10th December, 1954. (747883.)

4192. Standard Telephones & Cables, Ltd.—Electrical circuits for transferring information between information storage circuits. 29th September, 1950. (747847.)

4810. Bendix Aviation Corporation.— Cam actuated electric make-and-break switches. 18th February, 1954. (747885.)

4960. Philips Electrical Industries, Ltd.— Automatic gain control circuit arrangements for television receivers. 19th February, 1954. (747887.)

6538. Erie Resistor Corporation.—Resistors and method of making same. 5th March, 1954. (748111.)

9293. Foxcroft, R. C.—Electric switchgear for the automatic starting of internal combustion engines. 30th March, 1954. (747892.)

9614. British Thomson-Houston Co., Ltd. —Electro-conductive coatings on high temperature resistant substrates. 1st April, 1954. (747893.)

9616. Metropolitan-Vickers Electrical Co., Ltd.—A.c. commutator motors. 30th March, 1955. (748114.)

9720. Standard Telephones & Cables, Ltd.—Phase detectors. 2nd April, 1954. (747894.)

11836. Philips Electrical Industries, Ltd. —Carrier wave telephony systems. 23rd April, 1954. (747898.)

12601. Babcock & Wilcox, Ltd.—Combustion apparatus of the kind including a cyclone furnace. 30th April, 1954. (747929.)

12606. Philips Electrical Industries, Ltd. —Cathode-ray tubes comprising a metal cone and a glass window. 30th April, 1954. (747930.)

13923. Hazeltine Corporation.—Matrixing apparatus for a colour television system. 12th May, 1954. (748060.)

13936. Hercules Powder Co.—Static resistant electric initiator. 12th May, 1954. (747935.)

14054. Licentia Patent-Verwaltungs Ges. —Contact rectifier with cummutating reactors in series with the contacts. 13th May, 1954. (747936.)

16514. Siemens-Reiniger-Werke Akt.-Ges.—High tension units, more particularly for a d.c. X-ray apparatus. 3rd June, 1954. (747938.)

19308. Philips Electrical Industries, Ltd. —Method of manufacturing multicore electric cables. 1st July, 1954. (747945.)

19437. Standard Telephones & Cables, Ltd.—Manufacture of electrolytic capacitors. 2nd July, 1954. (747946.)

20606. Dow Chemical Co.—Electric primary cell. 14th July, 1954. (748065.) 20715. Electric dry cell. 15th July, 1954. (747949.)

24757. General Motors Corporation.— Electric motor. 25th August, 1954. (747989.)

24960. Philips Electrical Industries, Ltd. —Variable inductors. 27th August, 1954. (747991.)

25158. Valiulis, S. J.—Stand-off electric insulator. 30th August, 1954. (747992.)

26297. Officine Galileo Soc. Per Azioni. —Hunting damper device for small synchronous motors of the so-called reaction type particularly for applications in apparatus designed to the measure of time. 10th September, 1954. (747995.)

33563. Westinghouse Electric International Co.—Electric motor control systems. 19th November, 1954. (748120.)

36757. Philips Electrical Industries, Ltd. —Methods of manufacturing ferromagnetic cores having substantially rectangular hysteresis loops. 20th December, 1954. (748070.)

**1955**

28268. Irving Air Chute of Great Britain, Ltd.—Electrical severing device. 1st June, 1954. (748009.)

## CATALOGUES AND LISTS

**CONDUIT FITTINGS.**—Price list of the company's range of earth clips, adaptable boxes and buckle clips.—**Villa Tool & Manufacturing Co., Ltd.,** Howe Street, Birmingham, 4.

**DOMESTIC APPLIANCES.**—Illustrated and priced catalogue showing a range of domestic electrical appliances.—**Wholesale Electric Co., Ltd.,** 37, Vauxhall Bridge Road, London, S.W.1.

**ELECTRICAL AND ENGINEERING SUPPLIES.**—256-page illustrated priced catalogue dealing with a range of electrical and engineering supplies.—**A. E. Dees, Ltd.,** 24-26, Carliol Street, Newcastle-upon-Tyne, 1.

**HEATING APPLIANCES.**—16-page illustrated catalogue of process heating appliances for factory and workshop, including tinning and metal pots, kettles and wax tanks, small furnaces and ovens.—**Barlow-Whitney, Ltd.,** 2, Dorset Square, London, N.W.1.

**LIGHTING FITTINGS.**—46-page priced catalogue of commercial and decorative lighting fittings.—**Philament Electric, Ltd.,** Kent Road, Industrial Estate, Bridgend, Glam.

**LIMIT SWITCH.**—Illustrated folder describing the company's ball-headed plunger type limit switch.—**Brook Motors, Ltd.,** Empress Works, Huddersfield.

**SEWING MACHINE.**—Leaflet describing a new "Viking" automatic electric home sewing machine.—**Viking Sewing Machine Co., Ltd.,** 67-73, Worship Street, London, E.C.2.

**SOLDER PRODUCTS.**—Catalogue of solder products.—**Enthoven Solders, Ltd.,** 89, Upper Thames Street, London, E.C.4.

**SOLENOIDS.**—Folder illustrating various types of solenoids produced by the company and typical applications.—**Westool, Ltd.,** St. Helen's Auckland, Co. Durham.

**SWITCHGEAR.**—Leaflet (CR60) describing the "Crown" range of switch fuses and switch splitters, and leaflet (AC156) dealing with 30 and 60 A double-pole insulated switches.—**Bill Switchgear, Ltd.,** Aston Lane, Perry Barr, Birmingham, 20.

# CONTRACT INFORMATION

## Accepted Tenders and Prospective Electrical Work

### CONTRACTS OPEN

*Where "Contracts Open" are advertised in our "Official Notices" section the date of the issue is given in parentheses.*

**Angus.**—County Council. Two electrically driven booster pumps for the Carmyllie/Monikie water supply. County engineer, County Buildings, Forfar.

**Australia.**—31st May. Sydney County Council. 70 30 MVA, 415 V transformer switching equipments for substations. (E.S.B. 8895/56. Ten/18771.)*

**Ballymena (Co. Antrim).**—20th April. County Library Committee. Electrical installation in the County Library, Demesne Avenue. McCutcheon & Wilkinson, chartered architects, 21, Wellington Street.

**Belfast.**—3rd May. Corporation Electricity Department. Portable petrol engine driven pumping unit for Power Station West. (See this issue.)

**East Lothian.**—5th May. County Council. Street lighting equipment. (See this issue.)

**Fermanagh.**—3rd May. County Education Committee. Electrical installation at new secondary intermediate school, Enniskillen. McAuslan & Abbott, consulting engineers, 16, Bedford Street, Belfast.

**Formosa.**—25th April. Central Trust of China, Purchasing Department. Substation equipment including switchboard, transformers, lightning arrestors, fusible cutouts and circuit-breakers. (E.S.B. 8146/56/I.C.A. Ten/18695.)* 30th April. Electrical and radio equipment. (E.S.B. 8147/56/I.C.A. Ten/18696.)*

**India.**—24th April. Bombay Port Trust. H.v. and l.v. cables and accessories. (E.S.B. 8816/56. Ten/18745.)*

**Iraq.**—24th April. Directorate General of Municipalities. 50 kW diesel driven alternator set. (E.S.B. 8828/56. Ten/18752.)*

**Leeds.**—14th May. Regional Hospital Board. Electrical installation in radiotherapy centre at Cookridge Hospital. (See this issue.)

**New Zealand.**—14th May. General Post Office. 2,000 insulators. (E.S.B. 8384/56. Ten/18689.)* 16th May. Electrolytic capacitors. (E.S.B. 8382/56. Ten/18698.)* 17th May. 13,000 switchboard lamps. (E.S.B. 8837/56. Ten/18743.)* 18th May. Insulating tape. (E.S.B. 8385/56. Ten/18699.)* 22nd May. Cables, jointing and terminating materials. (E.S.B. 8840/56. Ten/18739.)* 24th May. Radio valves. (E.S.B. 8838/56. Ten/18737.)*

**Norway.**—25th May. Four 85 kVA and four 60 kVA diesel driven generators (Ref. 2/56); three 150 kVA diesel driven generators (Ref. 3/56); and supply and installation of a cable railway (Ref. 4/56). Firms wishing to tender should apply to Forsvarets Anleggsdirektorat, Parkveien 68, Oslo, by 20th April. (E.S.B. 8910/56. Ten/18726.)*

**Portuguese East Africa.**—27th April. Ports, Railways and Transport Department, Lourenço Marques. Electrical material including wire, circuit-breakers, switches, conduits, cable, and generating set, etc. (E.S.B. 7616/56. Ten/18730.)*

**South Africa.**—20th April. City of Durban, Electricity Department. 200-750 kVA three-phase transformers. (E.S.B. 8819/56. Ten/18744.)* Weatherproof striplighting contact sets and coloured lamps. (E.S.B. 8817/56. Ten/18748.)* 18th May. E.h.v. switchboards. (E.S.B. 8820/56. Ten/18753.)*

26th April. Union Tender and Supplies Board. Telephone dial mountings. (E.S.B. 8882/56. Ten/18755.)*

27th April. Stores Department, South African Railways. Switchboards. (E.S.B. 8396/56. Ten/18691.)* 4th May. Cable. (E.S.B. 8876/56. Ten/18727.)* Three channel carrier equipment. (E.S.B. 8873/56. Ten/18768.)*

**Surrey.**—28th April. County Council. Street lighting equipment. (See this issue.)

**Syria.**—21st May. Ministry of National Defence, Damascus. Wireless transmitters. (E.S.B. 8942/56. Ten/18756.)*

**Uruguay.**—15th May. Administracion General de las Usinas Electricas y los Telefonos del Estado. Electricity meters. (E.S.B. 9010/56. Ten/18757.)* 16th May. Copper conductors. (E.S.B. 9013/56. Ten/18758.)* 17th May. Insulation material. (E.S.B. 9011/56. Ten/18760.)*

25th May. Administracion Nacional de Puertos. Electric installation materials. (E.S.B. 9002/56. Ten/18765.)*

**Waterford.**—30th April. Mental Hospital Board. Electrical installation in the District Mental Hospital. Chief Clerk, District Mental Hospital, Waterford.

* Specifications may be inspected at the Export Services Branch, Board of Trade, Lacon House, Theobald's Road, London, W.C.1 (Chancery 4411; extension 769).

### ORDERS PLACED

**Bridport.**—Corporation. Recommended. Steel columns and electrical equipment for street lighting scheme (£3,984).—Revo Electric Co.

**Chertsey.**—U.D.C. Recommended. Mercury vapour units of group "A" type in Church Road, Brighton Road, and in New Haw Road, Addlestone (£4,706).—Revo Electric Co.

**Llandudno.**—U.D.C. Completion of street lighting conversion to electricity (£13,392).—General Electric Co.

**Northumberland.**—Education Committee. Accepted. Electrical installations in schools: Ashington Hirst South County Primary School (£156) and Felton C.E. Controlled School (£134).—A. Hagerty. Beal County Primary School (£173).—Crosshill Electric. Bowsden County Primary School (£124).—South of Scotland Electricity Board. Branton County Primary School (£151).—I. and E. Morton. Falstone County Primary School (£177).—O. R. Porteous. Gosforth Boys' Secondary School (£110).—Falconar Cross and Co., Ltd. Herdley Bank Primary School (£219).—A. Moffett & Sons. Wallsend Technical Institute (£657).—Bonham Electric Co.

**Sandown-Shanklin.**—U.D.C. Two 20-passenger geared electric lifts.—Waygood-Otis.

**Workington.**—Newcastle Regional Hospital Board. Electrical installation works at new tuberculosis unit at Hensingham (£3,778).—Thomas Armstrong, Ltd.

### WORK IN PROSPECT

*Particulars of new works and building schemes for the use of electrical installation contractors and traders. Publication in this section is no guarantee that electrical work is definitely included. Alleged inaccuracies should be reported to the Editors.*

**Basildon.**—Houses (37), Hickstars Lane site, Billericay; U.D.C. surveyor, 108, High Street, Billericay.

**Berwick.**—Houses (160); borough surveyor.

**Birmingham.**—Erection of Hagley Road, Lordswood, County Girls' Technical School; B. Whitehouse & Sons, Ltd., 247, Monument Road.

**Blackpool.**—Factory and offices; D. Stansfield, Ltd., Clifton Road, Marton.

Dwellings (151), Grange Park estate extension; Middleton & Co., Ltd., builders, Bank Street.

**Blaydon (Co. Durham).**—Houses (40), Pipe Bridge; U.D.C. surveyor.

**Bournemouth.**—Workshops and offices, Ringwood Road; Boyland & Son, Ltd., Fernheath Road.

**Brandon.**—Convent at Burn Hall for St. Joseph's Foreign Mission College (£30,000); J. Cummings, builder, Matamba Terrace, Sunderland.

**Brentwood.**—Houses (150), Hutton; U.D.C. surveyor, Council Offices, Ingrave Road.

**Bridlington.**—Houses (48), Sewerby Road; S. Briggs, town clerk, Town Hall.

**Bristol.**—Bank at Merchants' Way/Regent Street corner site, Clifton; Westminster Bank, Ltd., 41, Lothbury, London, E.C.2.

**Chelmsford.**—Houses (97), Springfield Place estate; Stanley Bragg, architect, 119, High Street.

**Chester.**—Houses (76) and flats (16) at Hare Lane; Lloyd & Cross, Ltd., Argyle Street, Birkenhead.

**Church Stretton.**—Covered market hall on Town Hall site; U.D.C. surveyor.

**Colindale.**—Office block, Colindeep Lane; Howard Farrow, Ltd., 1, Russell Parade, London, N.W.11.

**Consett.**—Houses (32), Ebchester; U.D.C. surveyor.

**Coventry.**—Flats (126), Henley Green estate; C. F. Redgrave & Partners, architects, 6, Quadrant, Warwick Road.

Factory, Union Street; Godiva Fireplaces, Ltd., 32, Earl Street.

**Crewe.**—Houses (90), Naylor Street; L. Reeves, borough surveyor, Municipal Buildings.

**Daventry.**—Extensions to factory, Braunston Road, for British Timken, Ltd.; B. Sunley & Sons, Ltd., 34, St. James Street, London, S.W.1.

**Durham.**—Grammar/technical school at Barnard Castle; county architect, South Street, Durham.

**Eccles.**—Houses (60), Kearsley Street; A. Locke, Ltd., builders, 160, Higher Road, Urmston.

**Edgware.**—Factory, Wager's Yard, High Street; Punfield & Barston, Ltd., Basil Works, Westmoreland Road, London, N.W.9.

**Elland.**—Houses (100); F. R. Birkhead, U.D.C. surveyor, Council Offices.

**Evesham.**—Houses (46), Fairfield No. 7 site; Pemberton & Bateman, architects, 21, Vine Street.

**Gateshead.**—Additions to Technical College (£113,000); borough engineer, Municipal Buildings.

**Grantham.**—County secondary school at Earlsfield for Kesteven C.C.; Rudd & Son, Ltd., Wharf Road.

**Grimsby.**—Houses (30), Spring Street, Immingham; R.D.C. surveyor, 1, Chantry Lane.

**Halifax.**—Technical high school for E.C.; Pickles Bros. (Builders), Ltd., Gibbett Street.

**Hereford.**—R.C. church, Belmont Road; F. R. Bates & Son, architects, Imperial Chambers, High Street, Newport, Mon.

Additional factory buildings; Henry Wiggin & Co., Ltd., Holmer Road.

**Huddersfield.**—Houses (65), with seven shops and six garages, Lindley redevelopment area; borough architect, High Street Buildings.

**Jarrow.**—Grammar school; county architect, Durham.

**London.**—Office block, Noble Street; Trollope & Colls, Ltd., builders, 41-44, Great Queen Street, W.C.2.

Maisonnettes (42), Hilldrop Lane, Islington; E. C. P. Monson, architect, 120, Moorgate, E.C.2.

**London.**—Physics and engineering blocks for Imperial College of Science and Technology, South Kensington; Norman & Dawbarn, architects, 5, Gower Street, W.C.1.

Additional factory premises; Hilger & Watts, Ltd., 92-100, St. Pancras Way, N.W.1.

**Manchester.**—Seven-storey office block at Lloyd Street for Lloyd Street Properties, Ltd.; J. Gerrard & Sons, Ltd., Swinton, near Manchester.

Laboratories, Textilose Road, Stretford; Courtaulds, Ltd., Foleshill Road, Coventry.

**Morecambe.**—Church and school at Torrisholme; A. Robinson & Sons (Morecambe), Ltd., West End Road.

**Newcastle-on-Tyne.**—Flats and maisonnettes (126), near Hodgkin Park; Cussins, Ltd., contractors, The Drive, Gosforth.

Houses (60), Walker Road; C. M. Yuill, Ltd., builders, Villiers Street, West Hartlepool.

**Norwich.**—Offices, showrooms and warehouse in Bethel Street; Walpamur Co., Ltd., paint and varnish manufacturers, 326, Kensal Road, London, W.10.

**Oldbury.**—Houses (101), Cakemore estate; Rock & Downes, Ltd., 115, Walsall Road, Aldridge.

**Seaham.**—Ambulance depot; county architect, South Street, Durham.

**Sheffield.**—Hotel on the Base Green estate; William Stones, Ltd., brewers, Cannon Brewery, Sheffield, 3.

Extension to University; J. W. Beaumont & Sons, architects, Danlee Buildings, Spring Gardens, Manchester.

**Sodbury.**—Houses at Yate and Sodbury (3,000), and at Little Stoke (1,000), in connection with Bristol overspill scheme; R.D.C. surveyor, Council Offices, Chipping Sodbury.

**Southampton.**—Flats (196), in three contracts, on Thornhill estate; borough engineer, Civic Centre.

Weston Park Secondary Modern Boys' School; G. H. Buckle & Partners, consulting engineers, 2, Harrington Gardens, London, S.W.7.

**South Shields.**—Houses (88), Whiteleas; L. W. Evans, Ltd., contractors, 18, Norfolk Street, Sunderland.

Junior school at Biddick Hall (£80,000); Gordon Durham and Co., contractors, East Boldon.

Second instalment of Marine and Technical College (£250,000); Henderson Brothers, builders, Smith Street.

**Stratford-on-Avon.** — County grammar school for girls at Shottery Manor; G. R. Barnsley, county architect, Shire Hall, Warwick.

**Sunderland.**—Extensions to College of Art (£68,000); A. V. Clerey, 14, Frederick Street.

**Swansea.** — Omnibus garage, William Street/Clarence Street corner site; United Welsh Services, Ltd., Head Office, Swansea Coach Station.

**Swindon.**—Shops (15) and maisonnettes (16), Walcot; Bare, Leaning & Bare, surveyors, 9, Lower Belgrave Street, London, S.W.1.

Factory for Plessey Co., Ltd., Vicarage Lane, Ilford (£395,000); T. Wilson & Son, Ltd., builders, 67, Sheep Street, Northampton.

**Twickenham.**—Laboratories and drawing offices for Technical College; Walter Lawrence & Son, Ltd., builders, 31, Sun Street, London, E.C.2.

**Vange.**—Houses (345) for Basildon Development Corporation; Basil Spence & Partners, architects, 48, Queen Anne Street, London, W.1.

**Warminster.**—Houses (76), Dene estate, Boreham; Snailum Huggins and Le Fevre, architects to U.D.C., 18, Brock Street, Bath.

**Watford.**—Works, Holywell; Farleigh Press, Ltd., Beechwood Works.

**West Bromwich.**—Office block, Union Road; Wm. Jackson (Langley Green), Ltd., Langley Road, Langley Green, Birmingham.

Three-storey stores; Braithwaite & Co., Ltd., Crown Bridge Works.

Houses (84), on sites at Clifford Road and Harvills Hawthorn estate; borough surveyor, Town Hall.

# NEXT WEEK'S EVENTS

*Organisers of electrical functions are advised to make use of the "Electrical Review" clearing house, Room 221, Dorset House, Stamford Street, London, S.E.1, to ascertain that proposed dates do not clash with others already arranged*

## Monday, 16th April

BIRMINGHAM.—James Watt Institute, 6.30 p.m. I.E.E. South Midland Graduates' & Students' Section. "Some Aspects of Research Methods," by S. W. Gough and F. E. Gough. (Joint meeting with the Graduates' and Students' Sections of the Institutions of Civil and Mechanical Engineers.)

Grand Hotel, 6.15 p.m. Birmingham Electric Club. "Developments in Extra High Voltage Transmission in Sweden," by A. J. Haselfoot.

BRISTOL. — S.W.E.B. Demonstration Theatre, Colston Avenue, 6 p.m. I.E.E. Western Supply Group. "Design and Construction of 132 kV Overhead Lines," by D. J. Jones.

IPSWICH.—Electric House, 7.15 p.m. Ipswich & District Electrical Association. Local Industries Night: "Farming," by G. W. Shaw.

LONDON.—Savoy Place, W.C.2, 5.30 p.m. Institution of Electrical Engineers, informal meeting. Discussion on "Inspection and Maintenance of Wood Poles," opened by K. L. May.

MANCHESTER.—Grand Hotel, 6.45 p.m. Institution of Works Managers, Manchester Branch. Annual general meeting.

STAFFORD. — Technical College, 7 p.m. I.E.E. North Staffordshire Sub-Centre. Three short papers. (Joint meeting with the Graduates' & Students' Section.)

## Tuesday, 17th April

COVENTRY.—Technical College, 7.15 p.m. A.S.E.E. Coventry Branch. "Refrigeration Heat Pumps."

EDINBURGH.—Carlton Hotel, North Bridge, 7 p.m. I.E.E. South-East Scotland Sub-Centre. "The Recent Search for and Salvage of the Comet Aircraft near Elba," by Cmdr. C. G. Forsberg, R.N., and G. G. MacNeice.

LIVERPOOL.—9, The Temple, Dale Street, 6 p.m. I.E.S. Liverpool Centre. Members' night. Open forum and brains trust.

LONDON.—Savoy Place, W.C.2, 5.30 p.m. I.E.E. Measurement and Control Section. "The Indirectly Heated Thermistor as a Precise a.c./d.c. Transfer Device," by F. C. Widdis and "A Bridge for the Measurement of Permittivity," by A. M. Thompson.

At the Institution of Civil Engineers, Great George Street, S.W.1, 5.30 p.m. Institution of Civil Engineers. "The Glen Shira Hydro-Electric Project," by J. Paton.

2, Savoy Hill, W.C.2, 6.30 p.m. A.S.E.E. London National Lecture: "Problems Encountered in Overseas Installations," by J. Flood.

PORTSMOUTH.—"Air Balloon," 598, Commercial Road, Mile End, 7.30 p.m. A.S.E.E. Portsmouth Branch. Lecturette.

## Tuesday, 17th April, to Saturday, 21st April

BLACKPOOL.—Norbreck Hydro. Institute of Metal Finishing. Annual conference.

## Wednesday, 18th April

BIRMINGHAM.—Edgbaston Golf Club, 1 p.m. Birmingham Electric Club. Golf competition.

BOLTON.—2, St. George's Road, 7 p.m. I.E.E. North-Western Graduates' & Students' Section. "The Application of Protective Gear to a Distribution System," by G. Collier and R. Brown.

CHIPPENHAM.—At the Westinghouse Brake & Signal Co., Ltd. I.E.E. Bristol Graduates' & Students' Section. "Power Plants for Telephone Repeater Stations," by B. J. Woollett.

KENDAL. — N.W.E.B. Demonstration Theatre, Finkle Street, 7.15 p.m. I.E.E. North Lancashire Sub-Centre. "Fluorescent Discharge Tube Circuits and Operating Problems," by J. Cates.

LONDON.—Savoy Place, W.C.2, 6.30 p.m. I.E.E. London Graduates' & Students' Section. Address by the President, Sir George H. Nelson.

John Adam Street, W.C.2, 2.30 p.m. Royal Society of Arts. "T. H. Huxley and Technical Education," by Dr. C. Bibby.

At the Institution of Civil Engineers, Great George Street, S.W.1, 5.30 p.m. Institute of Fuel, London Section. Annual corporate meeting.

NOTTINGHAM. — County Hotel, Theatre Square, 7 p.m. Incorporated Plant Engineers, East Midlands Branch. "A Personal Approach to the Design of Control Gear," by J. B. Saunders.

SHEFFIELD.—Grand Hotel, 6.30 p.m. I.E.E. Sheffield Sub-Centre. "Atomic Energy in Industry," by Dr. J. N. Hill.

## Thursday, 19th April

BLACKBURN.—Golden Lion Hotel, 7.30 p.m. Incorporated Plant Engineers, Blackburn Branch. "Electronics in Industry," by A. Worland.

CANTERBURY. — County Hotel, 8 p.m. A.S.E.E. Kent Branch. "Radio and Television Interference," by C. E. Hollingworth.

DUBLIN.—Trinity College, 6 p.m. I.E.E. Irish Branch. Annual general meeting.

HULL. — Y.E.B., Ferensway, 7.15 p.m. I.E.E. North Midland Centre. "Automatic Circuit Reclosers," by G. F. Peirson, A. H. Pollard and N. Care.

LONDON.—Savoy Place, W.C.2, 5.30 p.m. I.E.E. Utilization Section. "Temperature Rises in Electrical Machines as Related to the Properties of Thermal Networks," by Dr. J. J. Bates and Prof. A. Tustin, "Temperature Rises in Electrical Machines on Variable Load and with Variable Speed," by Prof. A. Tustin and Dr. J. J. Bates, and "Performance and Heating Curves for Motors on Short-Run Duties," by Prof. A. Tustin, D. F. Nettell and R. Solt.

I.E.E. London Graduates' & Students' Section. Visit to Waterloo Signal Box, S.E.1, at 6.45 p.m.

Palmerston Restaurant, Bishopsgate, 6 for 6.45 p.m. E.P.E.A., Southern Meter Engineers' Technical Group. Annual dinner.

Connaught Rooms, 12.30 for 1 p.m. Diesel Engineers' & Users' Association. Annual luncheon.

College of Preceptors, Bloomsbury Square, W.C.1, 7 p.m. Incorporated Plant Engineers, London Branch. "Civil and other Engineering Problems in District Heating Schemes," by W. A. Gregory-Carter.

MANCHESTER.—N.W.E.B., Town Hall Extension, 5 p.m. I.E.S. Manchester Centre. Annual general meeting, followed at 6 p.m. by members' night.

SOUTHAMPTON.—Polygon Hotel, 8 p.m. A.S.E.E. Southampton Branch. "Television, Past, Present and Future," by A. Parsons.

WATFORD.—Compasses Hotel, High Street, 8.15 p.m. A.S.E.E. Watford Branch. Branch lecturettes.

## Friday, 20th April

BELFAST.—Grand Central Hotel, 8 p.m. I.E.E. Northern Ireland Centre. Annual dinner-dance.

BRISTOL.—Royal Hotel, 7 p.m. I.E.S. Bath & Bristol Centre. Annual general meeting and film show.

LONDON.—Savoy Place, W.C.2, 6 p.m. I.E.E. Education Discussion Circle. Discussion on "Theories of Electromagnetic Induction," opened by Prof. G. W. Carter.

## Saturday, 21st April

LONDON.—I.E.E. London Graduates' & Students' Section. Visit to London Fire Brigade, S.E.1 (2.30 p.m.).

A.S.E.E. North-West London Branch. Theatre and supper party.

OXFORD.—Y.M.C.A., 10, George Street, 6.30 p.m. A.S.E.E. Oxford, Reading & Districts Branch. "Applications of Metal Rectifiers."